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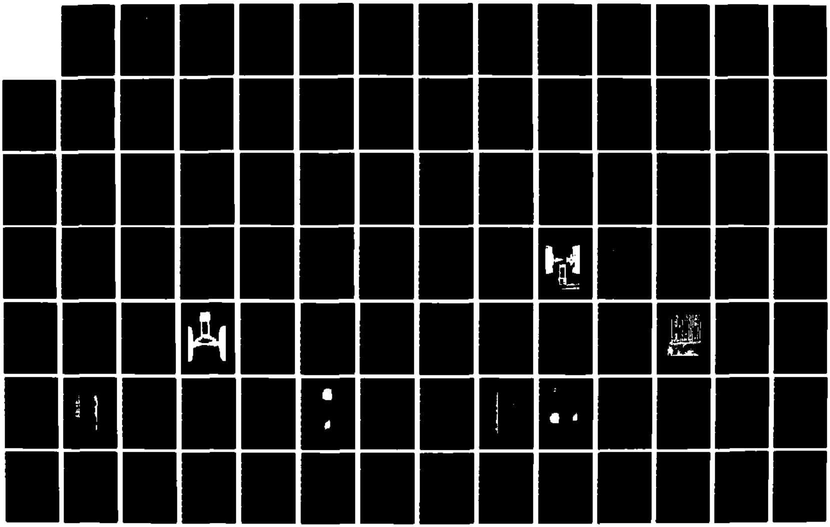

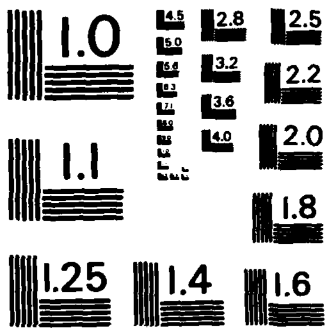
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REPORT NO. NADC-83126-60 (VOL. IV)

DEVELOPMENT OF FATIGUE AND CRACK PROPAGATION DESIGN & ANALYSIS METHODOLOGY IN A CORROSIVE ENVIRONMENT FOR TYPICAL MECHANICALLY-FASTENED JOINTS

VOLUME IV — PHASE II TEST AND FRACTOGRAPHIC RESULTS

D.E. Gordon, S.B. Kirschner and S.D. Manning
General Dynamics Corporation
P.O. Box 748, Ft. Worth, TX 76101

and

R.P. Wei
Lehigh University
Bethlehem, PA 18015

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FINAL REPORT
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains the test results and raw fractographic data acquired under Phase II of the corrosion fatigue program for mechanically-fastened joints. The results presented in this Volume (IV) are evaluated in ~~Volume III~~.

Variables included in the Phase II test program were material (7075-T7651 and Ti-6Al-4V), environment (dry air and 3.5% NaCl), load spectra (F-16 400 Hr. and F-18 300 Hr.), type loading (strain-controlled, constant amplitude,

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spectrum), stress level (a base-line stress; three alternate stresses), specimen conditioning (none; preconditioned), loading frequency (four loading rates), specimen type (strain controlled, compact tension and dog-bone); and bolt load transfer (0%, 20%, 40%). Most of the results ~~herein~~ are for 7075-T7651 aluminum alloy dog-bone specimens. These results were used to evaluate the corrosion fatigue analysis methodology for crack initiation and crack propagation in ~~Volume III~~. Ti-6Al-4V alloy results ~~herein~~ are limited to un-notched strain controlled tests. Further titanium research conducted under Phase II, including experimental results and evaluations, is documented in ~~Volume V~~. Vol. 5.

FOREWORD

This program was conducted by General Dynamics, Fort Worth Division (GD/FWD), with Lehigh University (Dr. R. P. Wei) as a subcontractor/consultant. This report (Vol. IV) documents the test and fractographic results obtained by General Dynamics under Phase II of the "Development of Fatigue and Crack Propagation Design and Analysis Methodology in a Corrosive Environment for Typical Mechanically-Fastened Joints" program (NADC Contract N6226-81-C-0268). The program was sponsored by the Naval Air Development Center, Warminster, PA, with Mr. P. Kozel as the project engineer. Dr. S. D. Manning of General Dynamics, Fort Worth Division, was the Program Manager/Principal Investigator and Dr. R. P. Wei of Leigh University was a co-investigator.

Several General Dynamics personnel supported the Phase II test program. D. E. Gordon coordinated the overall testing effort, procured specimens, performed the strain-controlled and the constant amplitude tests, eddy current inspections and fractographic evaluations. S. B. Kirschner coordinated the dog-bone specimen spectrum tests and per-

formed fractographic evaluations and data analyses. Dog-bone specimen spectrum tests and specimen dimensional checks were performed by R. O. Nay. Corrosion fatigue testing support was provided by F. C. Nordquist, J. W. Hagemayer and H. C. Hoffman. Dr. R. P. Wei of Lehigh University also assisted in setting up the test plan and provided valuable technical support.

The following reports (NADC-83126-60-) were also prepared under the Phase II effort:

- Volume III - Phase II Documentation
- Volume V - Corrosion Fatigue Cracking Response of Beta Annealed Ti-6Al-4V Alloy in 3.5% NaCl Solution

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SECTION I

INTRODUCTION

This report documents the test and fractographic results acquired by General Dynamics under Phase II of the corrosion fatigue test program. The test matrix, test setup, test procedures, specimen details, data acquisition methods, etc., are described herein. Raw fractographic results and supporting details are also presented. However, the conclusions and recommendations for the Phase II test program, including the evaluation of the test/fractographic results are presented in Volume III [1].

Most of the test and fractographic results presented herein are for the 7075-T7651 aluminum alloy. Results are also presented for strain-controlled specimens made from Ti-6Al-4V alloy. However, the Ti-6Al-4V alloy test results and evaluations that were conducted by Lehigh University as a part of the basic titanium research effort under Phase II are documented in Volume V [2].

A brief overview of the corrosion fatigue program for mechanically-fastened joints is given in Section II. The

corrosion fatigue (CF) test program for the Phase II effort is described in Section III. In Section IV, testing procedures and data acquisition methods, including fractography, are described. Strain-controlled test results for the 7075-T7651 aluminum alloy and the beta-annealed Ti-6Al-4V alloy are presented in Appendices A and B, respectively. Constant amplitude test results for dog-bone specimens of 7075-T7651 aluminum alloy are presented in Appendix C. Dog-bone specimen spectrum fatigue test results and applicable fractographic data are presented for Tasks 4, 5 and 6 in Appendices D, E and F, respectively.

SECTION II

CORROSION FATIGUE PROGRAM OVERVIEW

The purpose of this section is to review the overall objectives of the corrosion fatigue program for mechanically-fastened joints and to put the results of this Volume (IV) into perspective.

The main objectives of this program were to:

1. Develop and verify an analytical methodology for predicting the TTCI and crack propagation life of mechanically-fastened joints in a corrosive environment.

2. Develop corrosion fatigue test/data-acquisition methods and guidelines for acquiring statistically-valid data needed to implement the analytical methodology.

3. Study the effects of various factors on the corrosion fatigue behavior of mechanically-fastened joints.

The Phase I effort, documented in Volumes I and II [3,4], was concerned with three tasks as follows:

- Task 1 - Methodology and Data State-of-the-Art Assessment

- Task 2 - Methodology Development

- Task 3 - Test Plan Development

In Phase I the existing corrosion fatigue analysis methods were reviewed, the effects of various variables (i.e., stress level, R-ratio, loading frequency, environment hold-time, etc.) on TTCI and crack growth were experimentally investigated and evaluated for two different materials (7075-T7651 aluminum alloy and beta-annealed 6Al-4V Ti alloy), and a test plan was developed for the Phase II effort. The most suitable corrosion fatigue analysis methods for predicting the TTCI and crack propagation for mechanically-fastened joints were recommended in Phase I for evaluation in Phase II. Constant amplitude corrosion fatigue data were acquired under the Phase I effort.

The Phase II effort, data acquisition and methodology evaluation, included three tasks:

- Task 4 - Experimental Methodology Development and Evaluation

- Task 5 - Acquisition of Data for Prediction of Environmentally-Assisted Crack Growth in Aircraft Joints

- Task 6 - Prediction Methodology Evaluation and Verification

The objectives of the Phase II effort were to: (1) develop and evaluate suitable experimental methods and specimens for acquiring corrosion fatigue data for mechanically-fastened joints, (2) acquire corrosion fatigue data needed to implement the predictive methods recommended under Phase I, (3) evaluate the effectiveness of the CF analysis methodology for predicting the fatigue life of mechanically-fastened joints under spectrum loading, and (4) evaluate the effects of various factors (e.g., loading frequency, R-ratio, stress level, load transfer, load spectra) on the TTCI and crack propagation in mechanically-fastened joints.

In Phase I it was found that the corrosion fatigue behavior of the Ti-6Al-4V alloy was very complex [3]. For this reason, the Phase II effort was mainly concerned with the demonstration and evaluation of the corrosion fatigue

methodology for 7075-T7651 aluminum alloy. In Phase II, the Ti-6Al-4V alloy investigations were limited to the development of a better understanding of the corrosion fatigue crack growth mechanisms and the effects of loading frequency were emphasized [2].

This volume (IV) documents the Phase II experimental test program conducted and includes the raw test and fractographic results. Phase II test/fractographic results presented in this Volume (IV) are evaluated in Volume III [1] and the conclusions and recommendations are also presented.

SECTION III

PHASE II TEST PROGRAM

3.1 INTRODUCTION

The purpose of this section is to describe what was tested under Phase II of the corrosion fatigue program for mechanically-fastened joints and to discuss overall test objectives. Detailed test procedures and methods for acquiring the experimental results are discussed in Section IV. A preliminary test plan for the Phase II effort was developed under Phase I and it is described in Volume I [3]. The preliminary test plan was periodically adjusted during the course of the Phase II effort so that future tests could build on the Phase II test results and needs.

3.2 PHASE II TEST OBJECTIVES

The main objectives of the Phase II test program were to:

1. Develop and evaluate suitable experimental methods and specimens for acquiring corrosion fatigue data for mechanically fastened joints (Task 4).

2. Acquire statistically-valid corrosion fatigue data needed to implement and "tune" the corrosion fatigue analysis methodology for spectrum loading applications (Task 5).

3. Provide statistically-valid experimental data for evaluating the effects of various factors (e.g., loading frequency, R-ratio, stress level, load spectra, and percent bolt load transfer) on the time-to-crack-initiation (TTCI) and time-to-failure (TTF) in fastener holes (Task 5).

4. Provide key experimental results for Ti-6Al-4V alloy for developing a better understanding of basic mechanism and the effects of loading frequency on fatigue crack growth (Task 5).

5. Provide corrosion fatigue test results for crack initiation and crack growth in fastener holes that can be used to evaluate the accuracy of analytical methodology described in Volume I [3] (Task 6).

3.3 TEST PROGRAM PHILOSOPHY

The corrosion fatigue behavior of mechanically-fastened joints is complex. Therefore, the following philosophy was reflected in the Phase II test program:

- o Minimize the number of test variables to isolate the effects of corrosion fatigue.
- o Use test replications to acquire statistically-valid data.
- o Consider the most fundamental elements of a mechanically-fastened joint (i.e., single hole, straight bore, protruding head fastener and fastener load transfer).
- o Develop a better understanding of the corrosion fatigue behavior of straight-bore holes - with and without: fasteners and load transfer through the fasteners.
- o Due to the complexity of corrosion fatigue, state-of-the-art analytical corrosion fatigue methodology should be developed and verified in progressive steps with increasing structural complexities. Develop

understanding and data for simple joints before considering more complex joints.

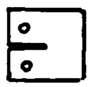
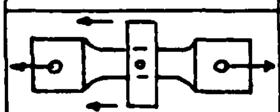
- Build on the test data and understandings from the Phase I effort.
- Develop and verify the corrosion fatigue analytical methodology for 7075-T7651 aluminum alloy.
- Develop a better understanding of the corrosion fatigue mechanisms for Ti-6Al-4V alloy [2].

3.4 TEST MATRIX AND DATA SET DESIGNATIONS

This section describes what was tested in Phase II. Key test variables reflected in the test program and testing rationale are also discussed in this section. However, detailed testing procedures and data acquisition methods are discussed in Section IV.

The Phase II corrosion fatigue program test matrix included 253 test specimens as noted in Table 1. Specimen details are shown in Figs. 1-3. A summary of the test variables used in Phase II is shown in Table 2.

TABLE 1 TEST SPECIMEN MATRIX FOR PHASE II

SPECIMEN		MATERIAL	NO. OF SPECIMEN			
CONFIGURATION	TYPE		TASK 4	TASK 5	TASK 6	Σ
 (Fig. 1)	S-C	7074-T7651	5	45	0	50
		Ti-6Al-4V	1	29	0	30
 (Fig. 2)	CT	Ti-6Al-4V	0	9*	0	9*
 (Fig. 3)	NLT	7075-T7651	23	90	3	116
 (Fig. 3)	LT	7075-T7651	2	3	43	48
		Σ	31	176	46	253

NOTES:

Task 4 - Experimental Methodology Development & Evaluation

Task 5 - Acquisition of Data for Prediction of Environmentally-Assisted Crack Growth in Aircraft Joints

Task 6 - Prediction Methodology Evaluation and Verification

S-C - Strain-controlled

CT - Compact Tension

NLT - No Load Transfer (through the fastener)

LT - Load Transfer (through the fastener)

* Results are documented and evaluated in Volume V [2].

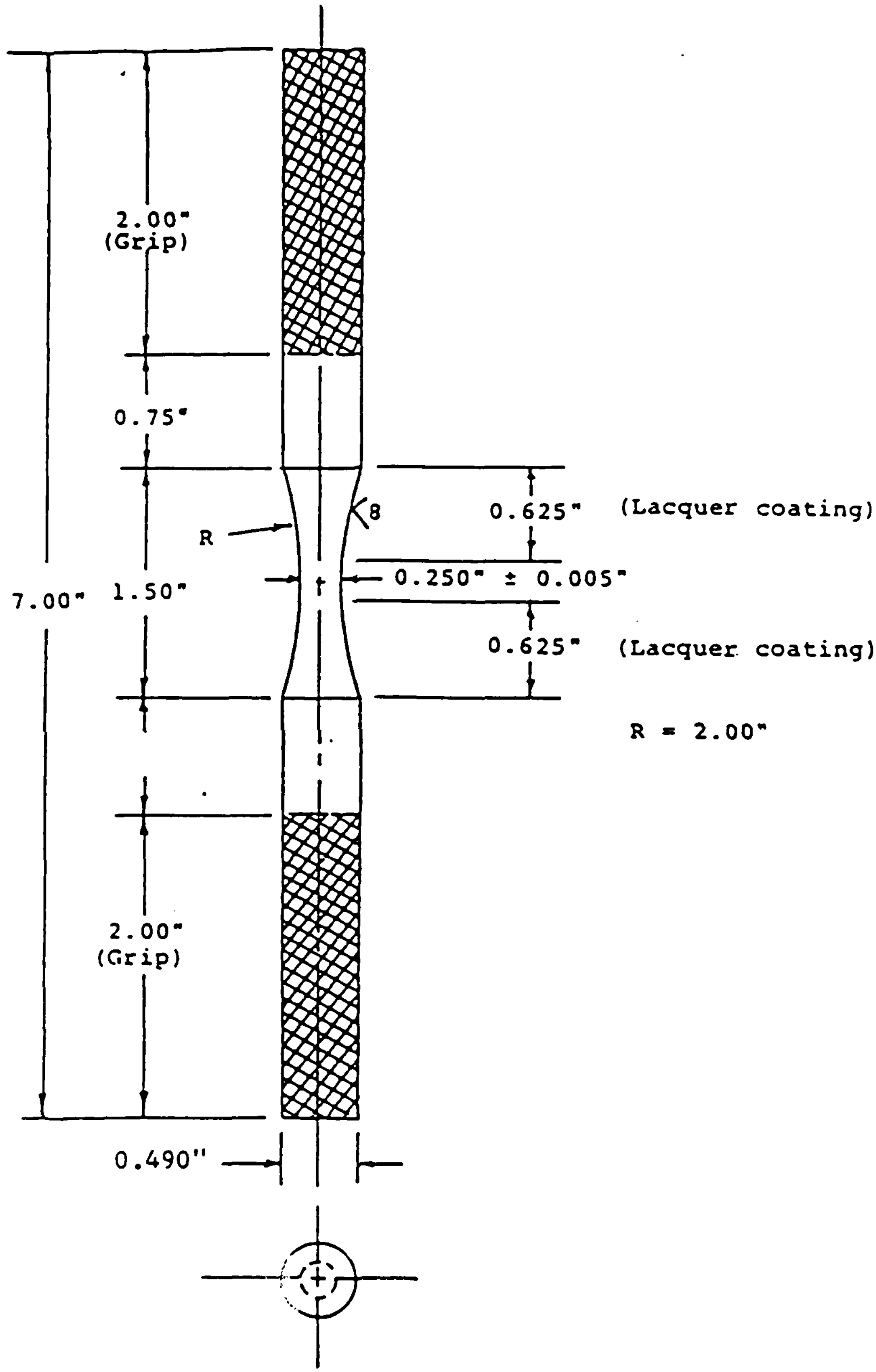
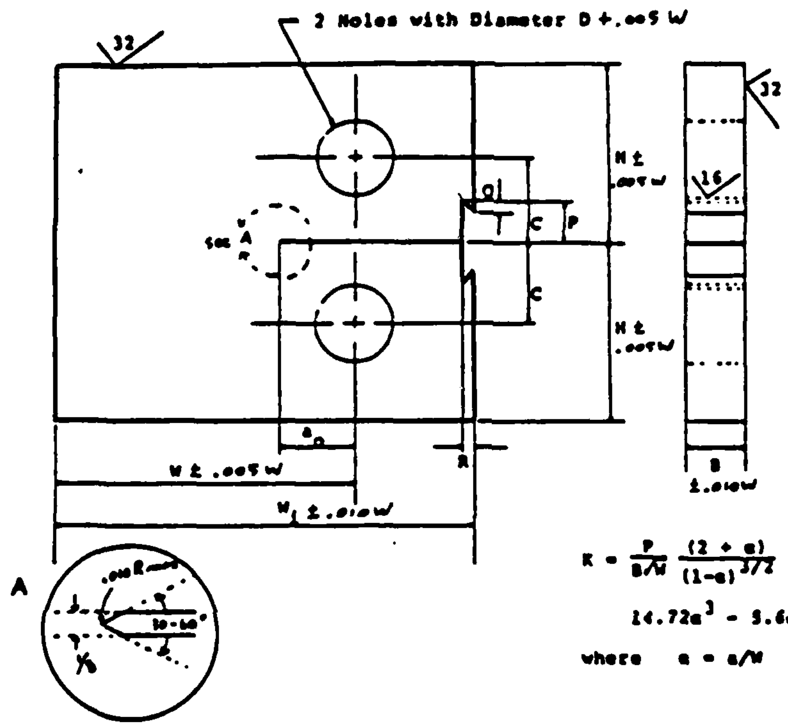


Fig. 1 Strain-Controlled Specimen



$$K = \frac{P}{B\sqrt{W}} \frac{(2 + \alpha)}{(1-\alpha)^{3/2}} (0.886 + 4.64\alpha - 13.32\alpha^2 + 14.72\alpha^3 - 5.6\alpha^4)$$

where $\alpha = a/W$

	B	a_0	W	H	W_1	C	D	P	Q	R
cm	1.26	1.59	6.35	3.81	8.90	1.78	1.59	0.889	0.254	0.254
in.	0.497	0.625	2.50	1.50	3.50	0.70	0.625	0.35	0.1	0.1

Fig. 2 Compact Tension Specimen for Beta-Annealed Ti-6Al-4V Alloy

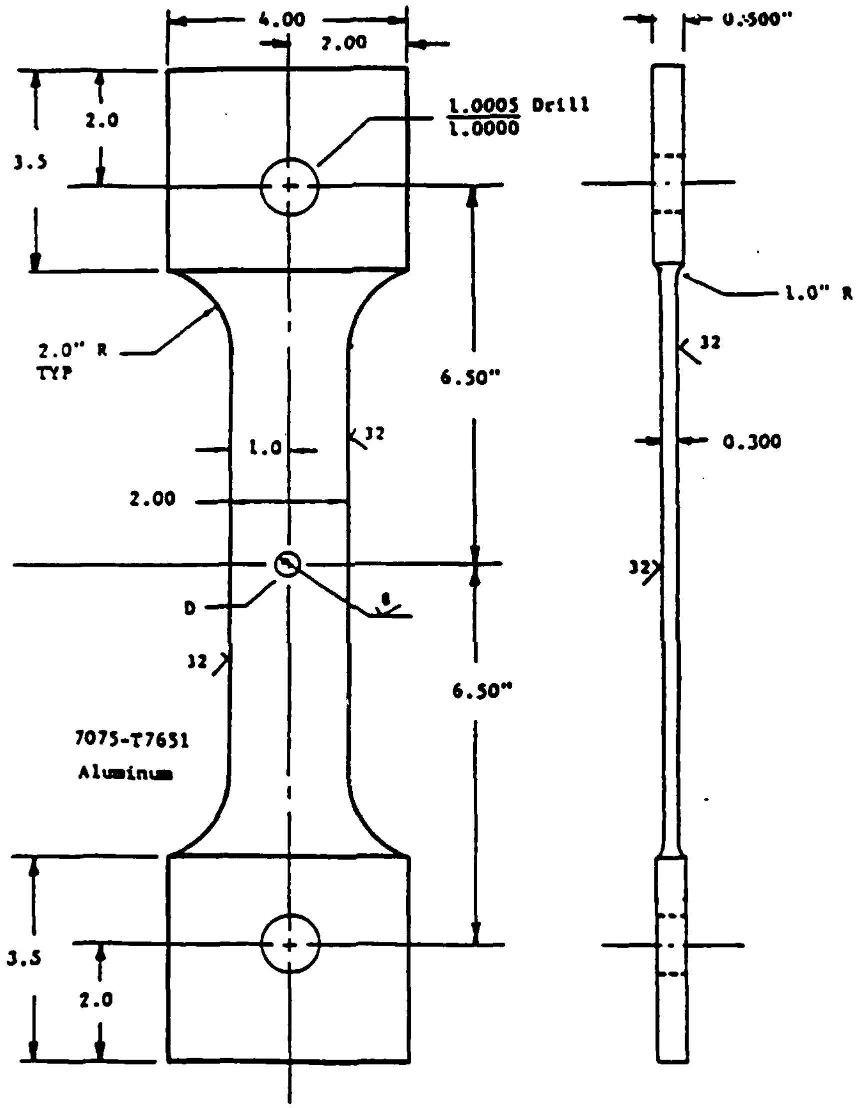


Fig. 3 Dog-Bone Specimen

TABLE 2 PHASE II TEST VARIABLES

MATERIAL	o 7075-T7651 ALUMINUM ALLOY o Ti-6Al-4V ALLOY
ENVIRONMENT	o DRY AIR o 3.5% NaCl SOLUTION
TYPE LOADING	o STRAIN-CONTROLLED o CONSTANT AMPLITUDE o SPECTRUM
LOAD SPECTRA	o F-16 400 HR. (HI-LO BLOCKS) o F-18 300 HR. (RANDOMIZED) o F-18 300 HR. (HI-LO BLOCKS)
LOADING FREQUENCY AND HOLD TIME	o CONSTANT AMPLITUDE (0.3 Hz TO 20 Hz) o SPECTRUM (FAST, SLOW, X-SLOW) o HOLD TIME (0 s TO 2.33 s)
TEST SPECIMENS	o UN-NOTCHED AXIAL (STRAIN-CONTROL) o COMPACT TENSION o DOG-BONE WITH CENTER HOLE
FASTENER HOLE	o OPEN (W/O BOLT) o WITH BOLT
BOLT HOLE FINISH	o POLISHED
BOLT TYPE	o STEEL PROTRUDING HEAD (CAD-PLATED) (e.g., NAS 6207)
BOLT LOAD TRANSFER	o 0% LT o 20% LT o 40% LT
STRESS LEVEL	o BASELINE STRESS o OTHER
SPECIMEN PRECONDITIONING	o NONE o PRETEST AND PRESOAK IN 3.5% NaCl

Test plans for Tasks 4, 5 and 6 are shown in Tables 3-7. For tracking purposes, tests are defined by I.D. number and by data set. The total number of specimens tested under each data set and other testing details are shown in Tables 3-7.

3.4.1 Coding System for Tests

A coding system was devised to concisely describe the key test variables used in Tables 3-7 and to facilitate test identifications. The coding system used in this report is shown and illustrated in Table 8.

In Tables 3-7 tests are also identified by "data set number" so that test specimens can be grouped and identified by the applicable data set number. This system is used throughout this report.

3.4.2 Materials

Two materials were used for the Phase II testing: 7075-T7651 aluminum alloy and Beta-annealed Ti-6Al-4V. These materials are of particular interest because several Navy aircraft in service include these materials in the airframe and such materials are susceptible to corrosion fatigue. The 7075-T7651 aluminum alloy material was supplied as 0.50-inch plate. The Ti-6Al-4V material was in the form of 0.875-inch thick plate. These materials were

TABLE 3 EXPERIMENTAL METHODOLOGY DEVELOPMENT AND EVALUATION TESTS (TASK 4)

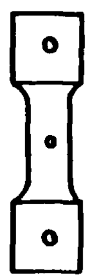
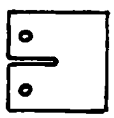
SPECIMEN	SPECTRUM	MATERIAL	TEST I.D.	DATA SET NO.	SPECIMEN DETAILS			ENVIRONMENT		FREQUENCY		NO. SPECIMENS TESTED
					% LT	BOLT?	PC?	DRY	3.5%NaCl	FAST	SLOW	
 (Fig. 3)	F-16 400 HR	7075-T7651	A-34/S/D	41	0	No	No	X	–	–	X	1
			A-34/F/W	42				–	X	X	–	1
			A-34/S/W	43				–	X	–	X	3
			A-32/S/D	44				X	–	–	X	3
			A-32/F/W	45				–	X	X	–	1
			A-32/S/W	46				–	X	–	X	3
			A-30/F/D	47				X	–	X	–	2
			A-30/S/D	48				X	–	–	X	1
			A-30/F/W	49				–	X	X	–	3
			A-30/20/S/W	50	20	Yes		–	X	–	X	1
			A-30/20/F/W	54	20	Yes		–	X	X	–	1
			A-28/F/W/B	51	0	Yes		–	X	X	–	1
			A-28/F/W/B/PC	52			Yes	–	X	X	–	2
			A-28/S/W/B/PC	53	0			–	X	–	X	2
 (Fig. 1)	CONSTANT AMPLITUDE (R = -1) (STRAIN CONTROLLED)		SC 1A	71	STRAIN SURVEY TESTS							5
		Ti-6Al-4V	SC 1T	81								1
												31

TABLE 4 STRAIN-CONTROLLED TESTS FOR TASK 5

LOADING	MATERIAL	TEST I.D.	DATA SET NO.	ENVIRONMENT		FREQUENCY	NO. SPECIMENS TESTED
				DRY	3.5% NaCl		
Constant Amplitude (R=-1)	7075-T7651	SC/D/A	72	X	-	VARIABLE	22
	7075-T7651	SC/W/A	73	-	X	VARIABLE	23
	Ti-6Al-4V	SC/D/T	82	X	-	VARIABLE	18
	Ti-6Al-4V	SC/D/T	83	-	X	VARIABLE	11
							74

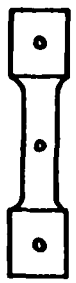
TABLE 5 Ti-6Al-4V ALLOY CRACK GROWTH TESTS FOR TASK 5

SPECIMEN	MATERIAL	ENVIRONMENT	K LEVEL			NO. SPECIMEN TESTED
			LOW	MED	HIGH	
	Ti-6Al-4V	Oxygen (Ref.)	X	-	-	2
			-	X	-	2
			-	-	X	2
		3.5% NaCl	X	-	-	1
			-	X	-	1
	Ti-6Al-4V		-	-	X	1
						9

Notes: 1. Ref. Volume I [3] for tests in vacuum.

2. Ref. Volume V [2] for testing details and results.

TABLE 6 DOG-BONE SPECIMEN TESTS FOR TASK 5



(Fig. 3)

SPECIMEN	SPECTRUM	MATERIAL	TEST I.D.	DATA SET NO.	SPECIMEN DETAILS			ENVIRONMENT		FREQUENCY			NO. SPECIMENS TESTED
					% LT	BOLT?	PC?	DRY	3.5% NaCl	FAST	SLOW	XSLOW	
(Fig. 3)	CONSTANT AMPLITUDE	7075-T7651	CA/F/D/PC	61	0	NO	YES	X	-	X	-	-	3
		7075-T7651	CA/F/W/PC	62	0			-	X	X	-	-	4
	F-16 400 HR. (BLOCK)	7075-T7651	A-28/F/D	1	0	NO	NO	X	-	X	-	-	4
			A-28/S/D	2				X	-	-	X	-	4
			A-28/F/W	3				-	X	X	-	-	4
			A-28/S/W	4				-	X	-	X	-	6
			A-28/[illegible]/W	5			NO	-	X	-	-	X	3
			A-28/F/D/PC	6			YES	X	-	X	-	-	3
			A-28/S/D/PC	7				X	-	-	X	-	3
			A-28/F/W/PC	8				-	X	X	-	-	3
			A-28/S/W/PC	9		NO	YES	-	X	-	X	-	4
			A-28/F/D/B	10		YES	NO	X	-	X	-	-	3
			A-28/F/W/B	11				-	X	X	-	-	4
			A-28/S/W/B	12			NO	-	X	-	X	-	2
			A-28/F/D/B/PC	13			YES	X	-	X	-	-	3
		7075-T7651	A-28/F/W/B/PC	14	0	YES	YES	-	X	X	-	-	3
	F-18 300 HR. (RANDOM)	7075-T7651	B-28/F/D	21	0	NO	NO	X	-	X	-	-	3
			B-28/S/D	22				X	-	-	X	-	3
			B-28/F/W	23				-	X	X	-	-	4
			B-28/S/W	24			NO	-	X	-	X	-	4
			B-28/F/D/PC	25			YES	X	-	X	-	-	3
			B-28/S/D/PC	26				X	-	-	X	-	3
			B-28/F/W/PC	27				-	X	X	-	-	4
		7075-T7651	B-28/S/W/PC	28	0	NO	YES	-	X	-	X	-	4
	F-18 300 HR. (BLOCK)	7075-T7651	C-28/F/D	33	0	NO	NO	X	-	X	-	-	3
		7075-T7651	C-28/F/W	34	0	NO	NO	-	X	X	-	-	3
	F-16 400 HR. (BLOCK)		A-28/20/F/W/PC	37	20	YES	YES	—	X	X	—	—	2
			A-28/20/S/W/PC	38	20	YES	YES	—	X	—	X	—	1
													93

TABLE 7 DOG-BONE SPECIMEN TESTS FOR TASK 6

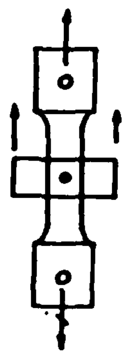
SPECIMEN	SPECTRUM	MATERIAL	TEST I.D.	DATA SET NO.	SPECIMEN DETAILS		ENVIRONMENT		FREQUENCY		NO. SPECIMENS TESTED
					% LT	PC?	DRY	3.5% NaCl	FAST	SLOW	
 (Fig. 3)	CONSTANT AMPLITUDE	7075-T7651	CA-23/20/F/D	63	20	NO	X	-	6 Hz	-	1
			CA-17/20/F/D	64			X	-		-	3
			CA-17/20/F/W	65	20		-	X		-	3
			CA-17/40/F/D	66	40		X	-		-	2
		7075-T7651	CA-17/40/F/W	67	40	NO	-	X		-	3
	F-16 400 HR. (BLOCK)	7075-T7651	A-28/20/F/D	15	20	NO	X	-	X	-	3
			A-28/20/F/W	16			-	X	X	-	2
			A-28/20/S/D	17			X	-	-	X	1
			A-28/20/S/W	18	20		-	X	-	X	2
			A-28/40/F/D	19	40		X	-	X	-	3
		7075-T7651	A-28/40/F/W	20	40	NO	-	X	X	-	3
	F-18 300 HR. (RANDOM)	7075-T7651	B-28/20/F/D	30	20	NO	X	-	X	-	4
			B-28/20/F/W	29	20		-	X	X	-	4
			B-28/40/F/D	31	40		X	-	X	-	3
		7075-T7651	B-28/40/F/W	32	40	NO	-	X	X	-	3
	F-18 300 HR. (BLOCK)	7075-T7651	C-28/40/F/D	35	40	NO	X	-	X	-	3
		7075-T7651	C-28/40/F/W	36	40	NO	-	X	X	-	3
											46

TABLE 8 CODING SYSTEM FOR DESCRIBING TESTS

ITEM	CODE
Type Test or Spectrum	o CA = Constant Amplitude Test o SC = Strain-Controlled Test o A = F-16 400 Hr. (Hi-Lo Block) o B = F-18 300 Hr. (Random) o C = F-18 300 Hr. (Hi-Lo Block)
Stress Level (ksi, gross)	o 28, 30, 32, 34 ksi
% Bolt Load Transfer	o 20 or 40 (Follows stress level if applicable)
Spectrum Loading Frequency	o F = Fast (8000 flt hrs/2 days) o S = Slow (8000 flt hrs/16 days) o X = XSlow (8000 flt hrs/90 days)
Environment	o D = Dry Air @ R.T. o W = 3.5% NaCl Solution @ R.T.
Bolt in Hole	o B = Bolt in Hole (Noted for 0% LT Tests)
Preconditioning	o PC = Specimen Preconditioned (Pretested and Soaked in 3.5% NaCl Solution

Examples:

(1) A-28/F/W = F-16 400 Hr. Spectrum; 28 ksi (gross) stress on test section; fast loading frequency; 3.5% NaCl environment

(2) A-28/20/S/D/B/PC = F-16 400 Hr. Spectrum; 28 ksi (gross) stress on test section; 20% bolt load transfer; slow loading frequency; dry air; bolt in hole; specimen preconditioned

from the same plates used for the Phase I testing. Material properties for these materials are presented in Volume I [3].

The 7075-T7651 aluminum alloy was emphasized in the Phase II test program and the test results were used to evaluate the corrosion fatigue methodology under Task 6.

The corrosion fatigue behavior of the Ti-6Al-4V alloy was found to be very complex in the Phase I effort [3]. Therefore, the Phase II experimental effort for this alloy was mainly concerned with developing a better understanding of the corrosion fatigue mechanisms and, in particular, the effects of loading frequency on crack growth. Test results for the strain-controlled specimens are presented in this report and the compact tension test results and evaluations, are presented in Volume V [2].

3.4.3 Test Specimen Design

Three specimen designs were used in the Phase II investigations. The test specimen details are shown in Figs. 1 - 3. Types of tests conducted with these specimens are shown in Table 1.

The hour-glass specimens shown in Fig. 1 is commonly used in strain-controlled experiments, where large strain

amplitudes are required. This specimen geometry is less susceptible to buckling than the commonly used longitudinal specimen. In our experiments, we felt that the NDI detectability of small cracks would be improved by using he hour-glass design specimen at low strain amplitudes also. All strain-controlled tests in both 7075-T7651 aluminum alloy and beta-annealed Ti-6Al-4V were conducted with the particular specimen geometry shown in Fig. 1.

All Ti-6Al-4V crack growth investigations conducted in Phase II were accomplished with the compact tension specimen shown in Fig. 2. This is the identical specimen design that was used for Ti-6Al-4V crack growth investigations in Phase I [3].

All of the constant amplitude and spectrum loaded stress controlled tests were conducted on the dog-bone specimen shown in Fig. 3. The same specimen design was used for both no-load transfer and load-transfer testing. Considerable experience has been obtained on this specimen design from previous investigations [5-7].

To minimize the effects of fastener hole quality (e.g., scratches in the bore) fatigue crack initiation, all fastener holes in the dog-bone test specimen were polished. Also, all steel fasteners were cad-plated to minimize the corrosive effects between dissimilar metals.

Most dog-bone specimens had a nominal hole diameter of 7/16 inch and a few specimen had a hole diameter of 1/2 inch. Specimen dimensions in the test section and hole diameters were measured and results were recorded.

A 7/16 inch diameter fastener hole was typically used so that the same dog-bone specimen design could be used for both no-load transfer tests as well as for 20% and 40% load transfer tests.

3.4.4 Environments

Specimens were tested in both dry air and 3.5% NaCl solution at room temperature. Several specimens tested in Tasks 4 and 5 were preconditioned (pretested and presoaked in 3.5% NaCl). Test chambers used for obtaining these environments plus the preconditioning procedure are discussed in Section IV.

3.4.5 Type Loading

The Phase II tests included three different types of loading: (1) strain-controlled, (2) constant amplitude and (3) spectrum. Strain-controlled tests were performed with un-notched specimens (Fig. 1) to acquire the data needed to implement the strain-life approach for making time-to-

crack-initiation predictions for loaded and unloaded fastener holes. Constant amplitude tests were performed using both compact tension specimens (Fig. 2) and dog-bone specimens (Fig. 3). Spectrum tests were also performed using dog-bone specimens.

3.4.6 Load Spectra

Corrosion fatigue tests were performed using three different load spectra: (1) F-16 400 Hour (Hi-Lo Blocks), (2) F-18 300 Hour (Randomized) and (3) F-18 300 Hour (Hi-Lo Blocks). Details of these test spectra are discussed in Section 4.6.

Dog-bone specimens of 7075-T7651 aluminum alloy were fatigue tested using the F-16 400 hour block spectrum to acquire experimental results for "tuning" corrosion fatigue analysis predictions for the time-to-crack-initiation (TTCI) and time-to-failure (TTF) in fastener holes.

Fatigue tests were also performed under Task 6 using dog-bone specimens and two variations of the F-18 300 hour spectrum. These tests provided results for evaluating the corrosion fatigue analysis predictive methodology for the time-to-crack-initiation and crack propagation for mechanically-fastened joints.

3.4.7 Loading Frequency

Tests were performed using different loading frequencies (ref. Tables 3-7) so that the possible effects of frequency and environment exposure time on the time-to-crack-initiation and crack growth could be assessed for the two alloys considered. Particular emphasis was placed on acquiring dog-bone specimen (7075-T7651) fatigue test results for three different loading frequencies: (1) Fast = flight hours/2 days, (2) slow = 8000 flight hours/16 days and (3) x slow = 8000 flight hours/90 days.

3.4.8 Bolt Load Transfer

Three different load transfers were used: (1) 0% both with and without a fastener in hole, (2) 20% load transfer, and (3) 40% load transfer. The percent bolt load transfer is defined as the percentage of the total input load to the dog-bone specimen (Fig. 3) reacted by the single bolt in the test section. The test setup used to obtain the 20% and 40% load transfers is described in Section 4.5.

All bolts were loaded in double shear to minimize the effects of bending and to focus attention on key variables: environment, load spectra, stress level, loading frequency and % bolt load transfer.

3.4.9 Stress Levels

Dog-bone specimens were fatigue tested at four different stress levels in Task 4, including 34 ksi, 32 ksi, 30 ksi and 28 ksi (gross). Task 4 was mainly concerned with developing and evaluating the experimental and corrosion fatigue data acquisition methods that would be used to conduct the fatigue tests under Task 5. Another objective of Task 4 was to determine a suitable baseline stress level that would be used for the corrosion fatigue tests of Tasks 5 and 6. After testing several dog-bone specimens at different stress levels, we selected a baseline stress of 28 ksi (gross). We selected a stress level that would assure fatigue cracking in a reasonable test and environmental exposure time.

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SECTION IV

TESTING DETAILS AND DATA ACQUISITION PROCEDURES

4.1 INTRODUCTION

The purpose of this section is to describe and discuss the essential elements of the Phase II test program (e.g., test specimen preparation test setups test spectra, and testing procedures). Also, the data acquisition procedures are discussed, including eddy current techniques, fractographic analysis methods and data extrapolations. Test results are presented in Appendix A-F.

4.2 SPECIMEN PREPARATION FOR TESTING

4.2.1 Strain - Controlled

Strain-controlled specimens (hour-glass type) shown in Fig. 1 were manufactured for both 7075-T7651 aluminum alloy and beta-annealed Ti-6Al-4V alloy. Specimens for the aluminum alloy and for the titanium alloy were machined from plate stock 0.50 inch and 0.875 inch thick, respectively.

After machining, all specimens were mechanically polished

in the hour-glass area to obtain a surface finish of 8 μ inch r.m.s. or better. All polishing was conducted parallel to the longitudinal axis of the specimen. Specimens were polished to help minimize the effects of manufacturing defects, such as small surface scratches, on the test results. Residual stresses were produced by the surface polishing. However, this result was considered more acceptable than the surface scratches for the test objectives intended.

4.2.2 Dog-Bone Specimen

All dog-bone specimens tested in Phase II were machined from 7075-T7651 aluminum alloy, 0.50 inch thick plate material. Specimen details are shown in Fig. 3.

After machining, a straight-bore center hole was drilled using the modified Winslow spacematic drill. This automatic drill unit maintains rotation during retraction to minimize surface scratches caused by the drilling operation.

Fastener holes were drilled per General Dynamics fastener installation standard M198 [8]. Standard hole diameters for the dog-bone specimens are shown in Table 9.

After drilling, the center hole in each specimen was mechanically polished using a split mandrel and metallographic polishing paper to obtain better than an 8 μ inch r.m.s.

TABLE 9 STANDARD HOLE DIAMETERS

Nominal Hole Dia. (Inch)	Hole Diameter (Inch)	
	Min	Max
1/4	0.2500	0.2540
7/16	0.4375	0.4425
1/2	0.5000	0.5050

Ref. General Dynamics Standard M198 [8].

surface finish. The purpose of the polishing was to minimize the effects of fastener hole quality on the fatigue test results. Also, we wanted to obtain test results that would be compatible as close as possible with the smooth un-notched strain-controlled data acquired.

After polishing the center hole of each specimen, the hole diameter, width and thickness of each specimen in the test section were measured. Results are recorded on the fractographic data sheets for each specimen in Appendices D-F.

4.2.3 Preconditioning

Selected dog-bone specimens from Tasks 4 and 5 were preconditioned as follows:

1. One block of the F-16 400 hour block spectrum was applied to the test specimen in lab air at a maximum spectrum stress of 28 ksi (i.e., peak load in spectrum produces 28 ksi stress on gross section of test specimen).

2. The specimen was then soaked in a 3.5% NaCl solution at room temperature for 72 hours.

3. Specimens were then cleaned and dried using the procedure described in AGARD report 695 [9].

4. If the preconditioned specimens were not fatigue tested immediately, they were stored at room temperatue in a plastic bag with desiccant until tested.

Specimen preconditioning was considered to complement the AGARD program effort [9] and to further evaluate the effects and of preconditioning on the time-to-crack-initiation and crack growth in fastener holes.

4.2.4 Fastener Type and Installation

Dog-bone specimens were fatigue tested with or without fasteners installed in the center hole. All fasteners used were cad-plated steel with a protruding head. NAS-6207 (7/16" dia.) and NAS-6208 (1/2" dia.) bolts were used where applicable. The standard minimum and maximum fastener diameter after cad-plating are 0.4360"/0.4370" and 0.4985"/0.4995" for the NAS-6207 and NAS 6208 bolts, respectively.

Some dog-bone specimens were tested with a NAS bolt and mating nut installed in the center hole with no-load transferred through the bolt (i.e., 0% LT). In this case a steel washer was used under the nut and the nut was installed "finger-tight".

4.3 ENVIRONMENTAL CHAMBERS

Two different environments were considered in the Phase II testing: dry air and 3.5% NaCl solution both at room temperature. Three basic environmental chamber designs were used to simulate the environment for the strain-controlled tests, for the no-load transfer dog-bone specimen tests and for the load transfer dog-bone tests. The environmental chamber designs used and the environment simulation procedures for the Phase II test program are described and discussed in the following subsections.

The salt water solution for the Phase II tests was prepared by dissolving reagent grade NaCl in triply-distilled water. The average solution pH was about 6.5 over the duration of each test. All Phase II salt water tests were performed in a constant immersion environment with periodic changing of the 3.5% NaCl solution to keep the solution fresh.

4.3.1 Strain-Controlled Tests

The environmental chamber for both dry air and 3.5% NaCl solution consisted of tygon tubing with an inside and outside diameter of 1/2 inch and 3/4 inch, respectively. A short piece of tubing, less than 2.00" in length, was first slipped over the strain-controlled specimen (Fig. 1) in the test section. The tubing was short enough to prevent any interference with the extensometer device. The tubing was

sealed at both ends with polysulfide sealant after mounting. The mounted environmenal chamber is shown in Fig. 4. For the dry air tests, desiccant was poured into the container before sealing the top. In the 3.5% NaCl solution experiments the salt water solution was added at an opening near the top of the chamber after the container had been sealed.

4.3.2 No-Load Transfer Dog-Bone Tests

Details of the environmental chamber used for the no-load transfer tests are shown in Fig. 5. This type of chamber was successfully used in the Phase I test program [3]. A chamber was mounted to each side of the dog-bone specimen over the center hole of the test section. The two chambers were clamped together to seal them against the specimen. The environmental chamber system described above was used for both constant amplitude and spectrum fatigue tests in Phase II.

The hole in the chamber allowed access for eddy current detection probes during testing to monitor fatigue crack initiation. A cork was placed in the hole when the chamber was in use. Environmental chambers were also used for dry air environemnt tests by placing desiccant crystals in the chamber.

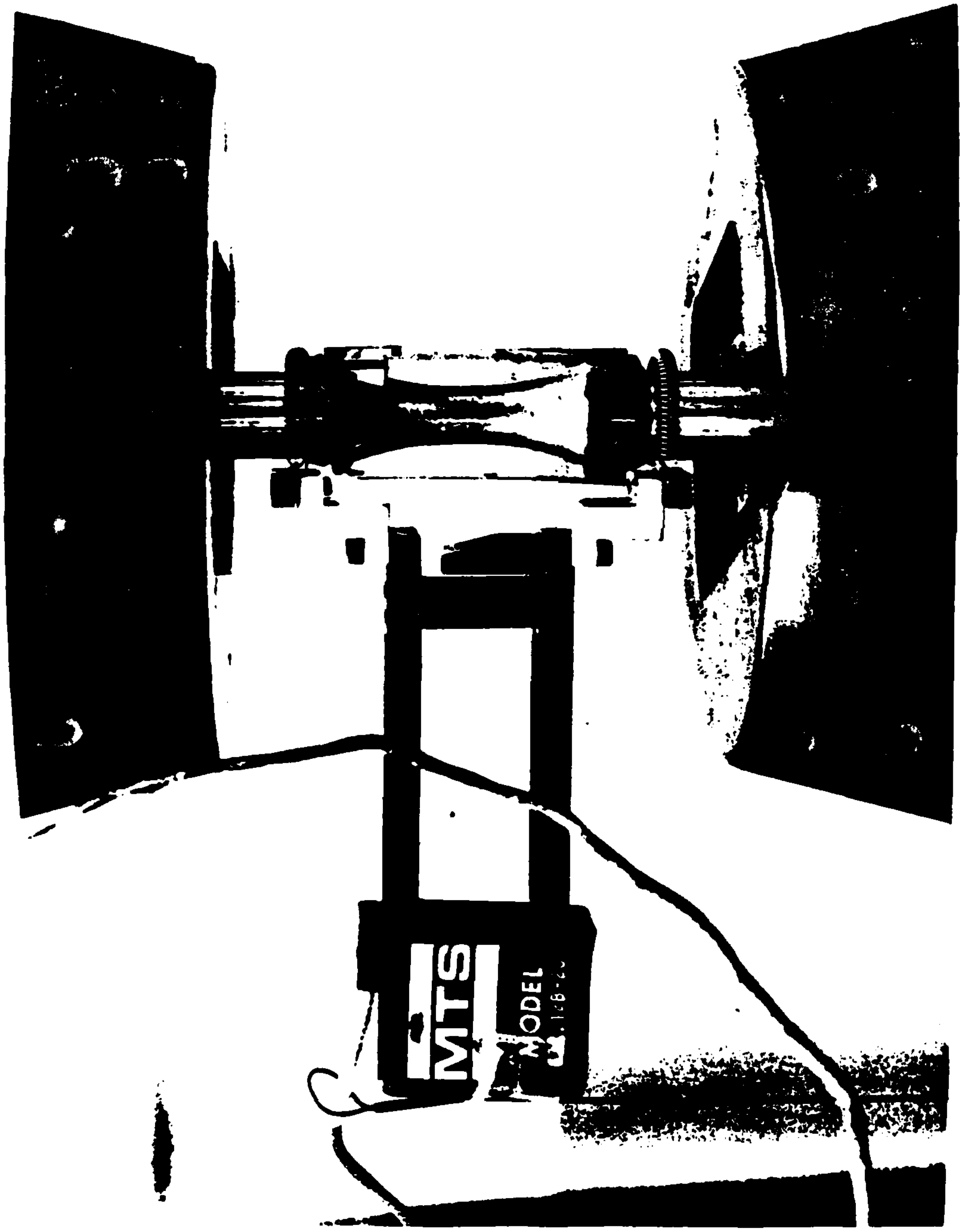


Fig. 4 Environmental Chamber and Test Setup for Strain-Controlled Tests

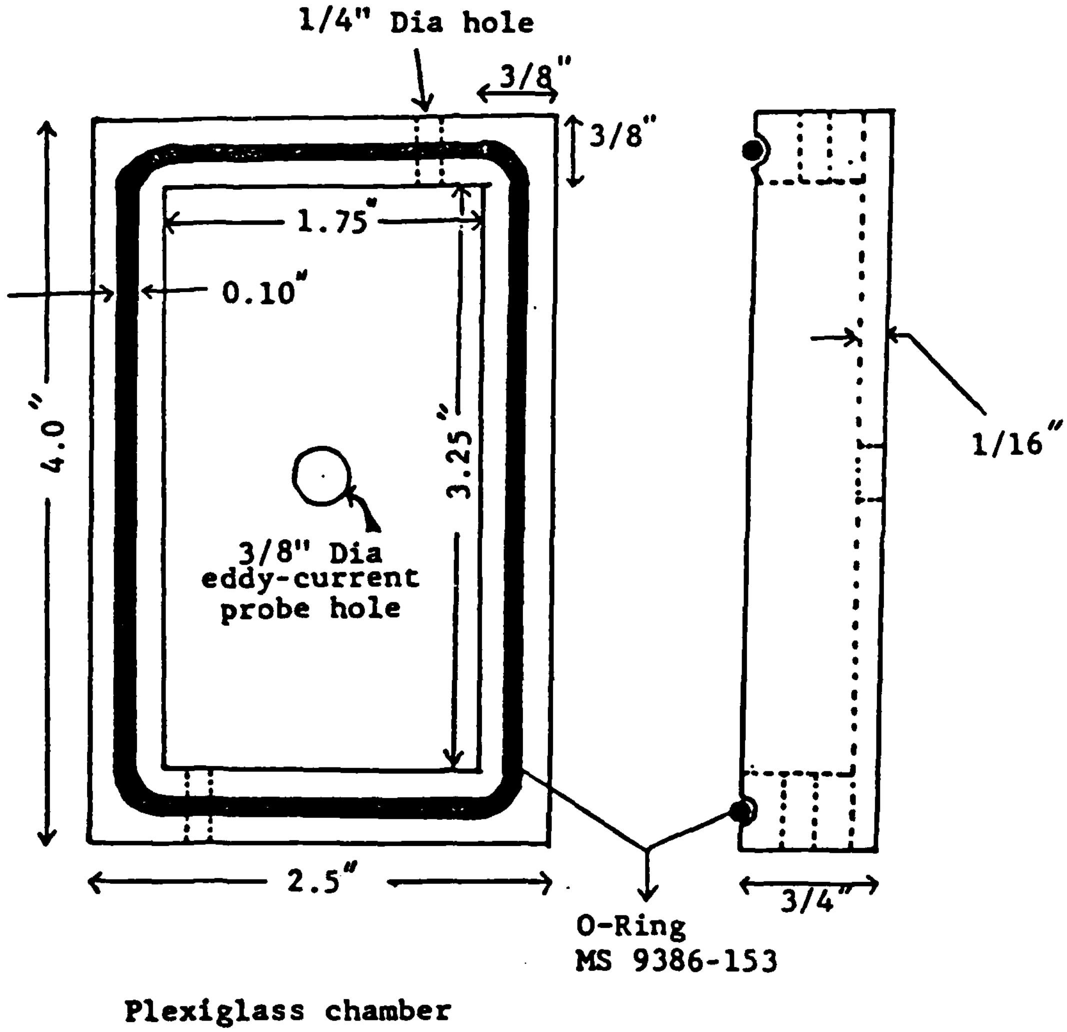


Fig. 5 Environmental Chamber Used for NO - Load Transfer Dog-Bone Tests

4.3.3 Load Transfer Dog-Bone Tests

The environmental chamber was an integral part of the loading bars used to transmit the ram loading directly to the bolt in the dog-bone specimen. Two loading bars, with the test specimen in the middle, were bolted together with a single 7/16" diameter steel bolt (clad plated) with a washer under the nut. An environmental chamber was formed in each loading bar by a counterbore (1.50" diameter and 0.10" deep) on the side facing the test specimen. A sealing groove with a rubber "O" ring surrounded the counterbore to seal the environmental chamber. A small torque was applied to the nut -- just enough to seal the environmental chambers against the surface of the test specimen. The loading bar assembly and details of the chamber are shown in Fig. 6.

Desiccant crystals were placed in the chambers to simulate a dry air environment. A 3.5% NaCl solution was added to the environmental chambers to simulate a salt water environment. Provisions were made in the chamber for draining the solution and for adding a fresh solution without disassembling the two loading bars.

4.4 STRAIN-CONTROLLED TESTS

Strain-controlled experimental procedures were developed in three stages: (1) calibrate strain-controlled specimen and ram loading, (2) evaluate environmental simulation methods, and (3) verify the time-to-crack-initiation (TTCI) acquisition method. Elements of the experimental methodology development

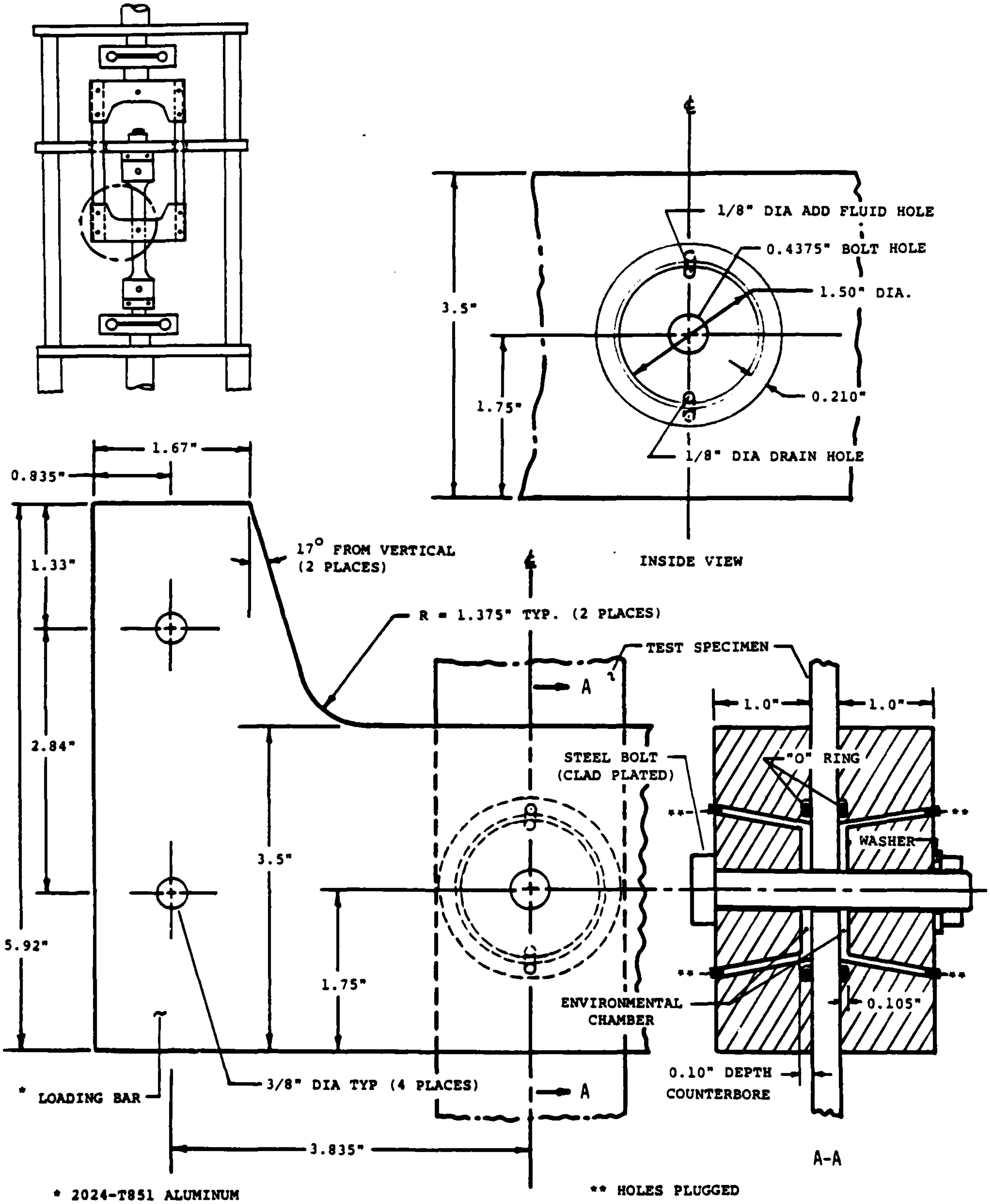


Fig. 6 Details of Integral Environmental Chamber Used In Loading Bar for Bolt Load Transfer Tests

are described in Fig. 7.

Experimental procedures were developed and verified for acquiring strain-controlled fatigue crack initiation data in dry air and in a 3.5% NaCl solution. Strain-controlled tests were conducted on fifty 7075-T7651 aluminum specimens and thirty beta-annealed Ti-6Al-4V alloy specimens as part of Tasks 4 and 5 (see Tables 1, 3 & 4). The experimental procedures used to acquire the crack initiation data are described in this section.

A total of 30 strain-controlled experiments were conducted on the beta-annealed Ti-6Al-4V alloy. Since the same experimental procedures developed for the aluminum alloy worked equally well for the titanium alloy, only one titanium specimen was needed for Task 4 (ref. Tables 1, 3 and 4). This specimen was used to conduct a strain survey. Crack initiation data was obtained for 29 test specimens.

4.4.1 Experimental Procedures

Total strain-controlled fatigue tests were performed on a closed loop hydraulic MTS machine (MTS Model 810.13, 22 kip capacity) controlled by fully reversed ($R' = \epsilon_{min}/\epsilon_{max} = -1$) sinusoidal strain amplitude waves. This system was used in conjunction with a 406.11 controller, 436.11 Control unit, Model 436.11 FG functional generator, 6 GPM hydraulic supply

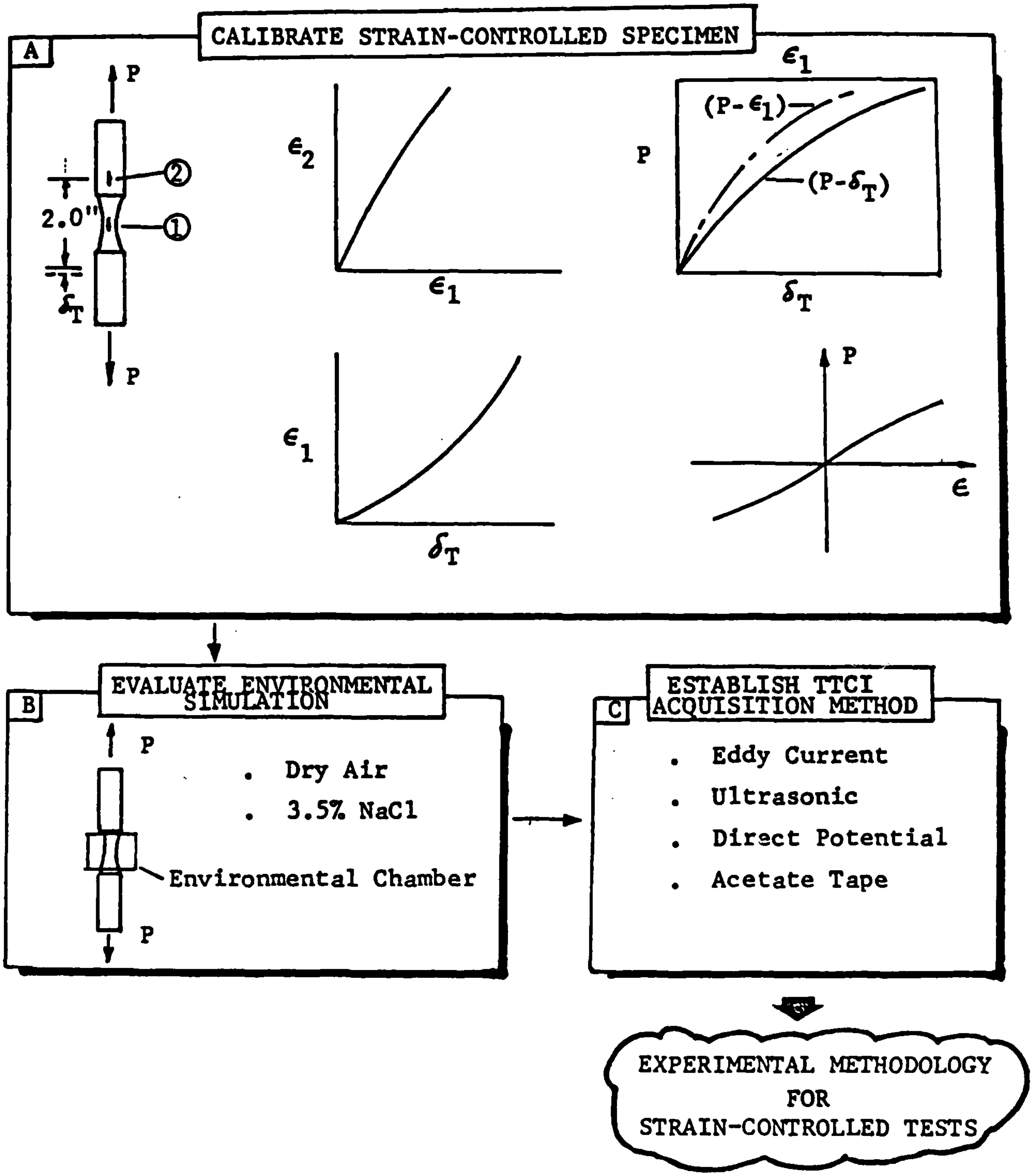


Fig.7 Elements of Strain-Controlled Experimental Methodology Development

and a digital indicator Model 430.41. Hydraulically operated grips (Model 641.92) were used. These grips are self-aligning to relieve possible bending stresses in the test specimens.

The aligning grips assured that the test machine axis was coincident with the specimen axis. For test specimens with strain gages, alignment was checked by observing the strain gage readings after the specimen was installed under zero applied load. Only very small strains were observed after installation in the test machine.

Normally, diametrical strain measurements are made on the hour-glass specimen. However, since many of the tests were conducted in a 3.5% NaCl environment, a two-inch gage length extensometer was mounted outside of the environmental chamber (Fig. 4). Extensometer voltage output (axial deformation) was measured as a function of axial strain in the reduced section of the specimen. These measurements were made by correlating extensometer voltage readings to strain gage readings for strain gages mounted axially in the minimum area section of the test coupon. Calibration curves based on these measurements are presented in Appendix A.

Strain surveys and strain-controlled specimen calibration tests were conducted to experimentally determine the relationship between ram load, axial strain and axial deformation (over 2.00" gage length). The test setup is shown

in Fig. 8. Four axial strain gages and an extensometer were mounted on the calibration specimen as shown in Fig. 9.

The instrumented specimen shown in Fig. 8 was statically loaded in tension and compression using a selected range of loads. Strain and extensometer measurements were taken at selected load levels. Typical results are presented in Appendix A for the 7075-T7651 aluminum alloy.

Calibration curves for 7075-T7651 aluminum alloy and Ti-6Al-4V alloy, respectively, were used to select extensometer voltages to obtain a specified strain value in the Task 5 experiments. The shape of the calibration curves were similar for both beta-annealed Ti-6Al-4V and 7075-T7651 aluminum alloys.

The environmental chamber used and simulation procedures for both dry air and 3.5% NaCl solution are described in Section 4.3.1.

In our experiments, most specimens were tested at a maximum total strain amplitude greater than .7% and at a test frequency of .5 Hz. This frequency was low enough to plot stress-strain hysteresis loops using the x-y recorder. For the long-life fatigue specimens, the frequency was increased to 2 Hz and 5 Hz to allow a large number of cycles to be accumulated in a reasonable period of time. During these

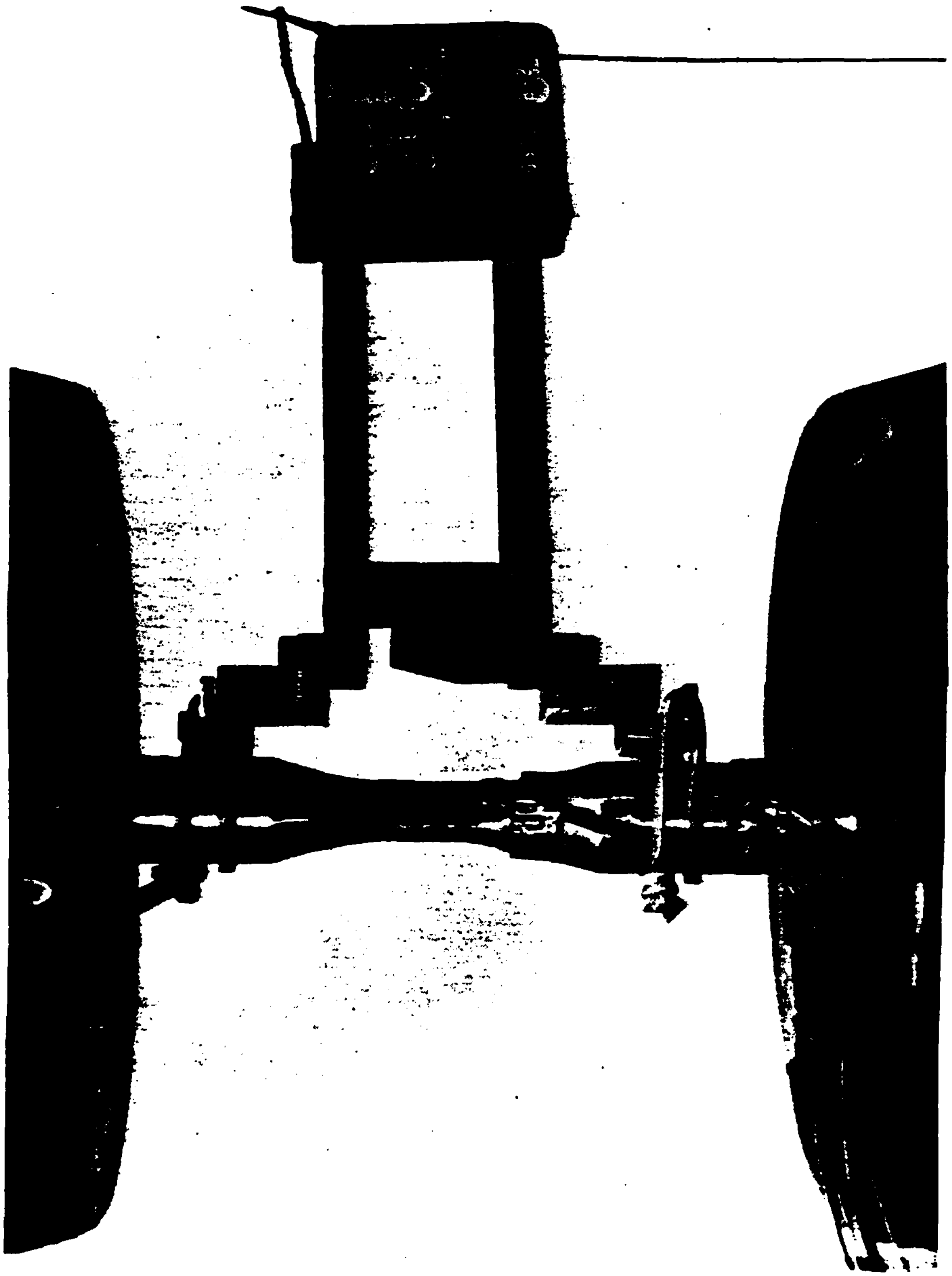


Fig. 8 Setup for Strain Surveys Using Strain-Controlled Specimen

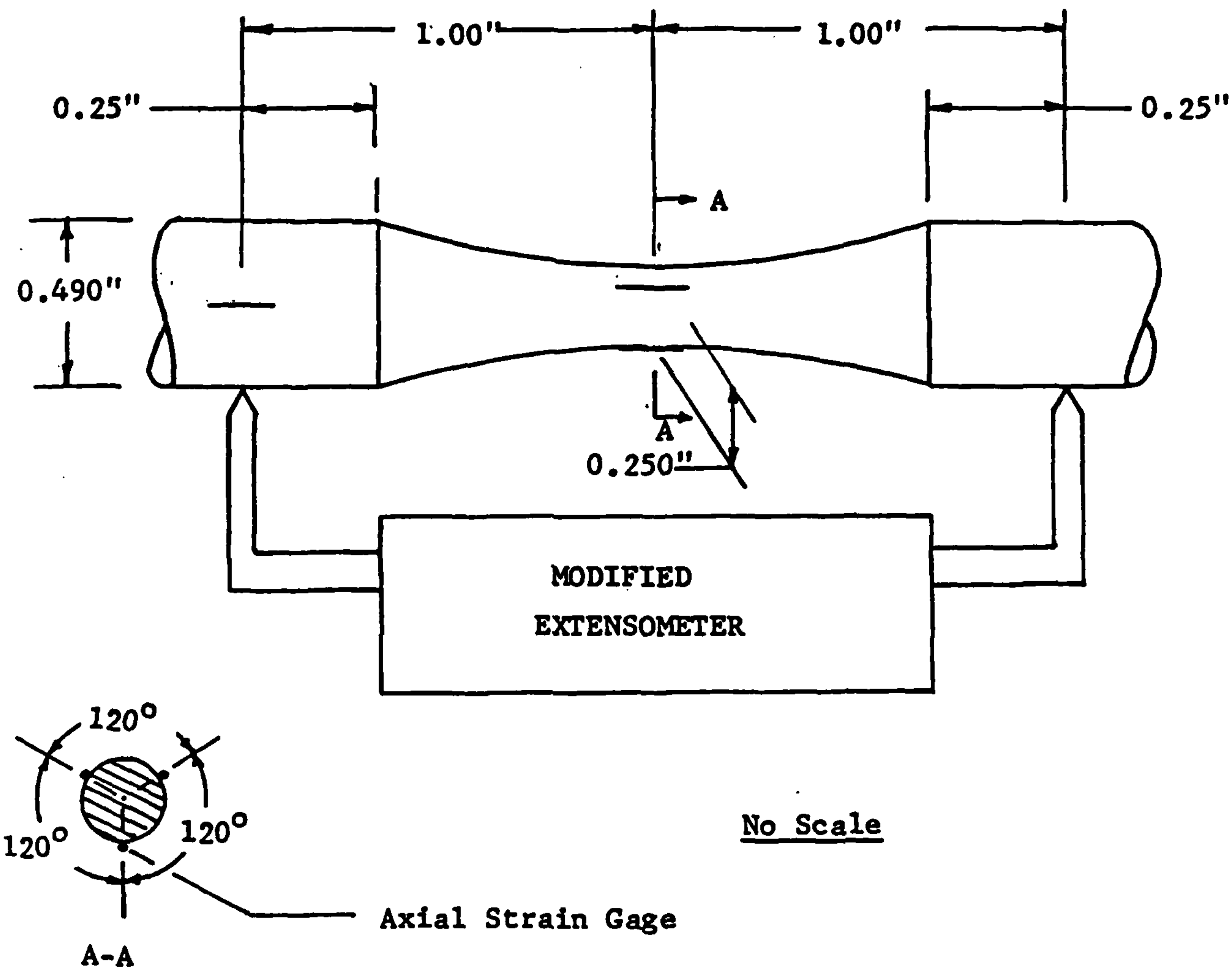


Fig. 9 Strain Gage Locations for Strain-Controlled Specimen

tests, test frequencies were lowered to .5 Hz at fixed intervals to make x-y plots. A few specimens were tested at several different frequencies corresponding to one strain amplitude value to investigate the effect of frequency on fatigue crack initiation.

During the constant strain tests, individual stress-strain hysteresis loops were recorded on a Moseley Model 7000A x-y recorder. All recordings were made at frequencies less than 1 Hz. An example fo the type of traces obtained are shown in Fig. 10. After recording the first few cycles, traces were obtained at periodic intervals, until testing ceased.

From the slopes of the stress-strain hysteresis loops, the elastic strain amplitude, $\Delta\epsilon_e/2$, and plastic strain amplitude, $\Delta\epsilon_p/2$, could be determined. This technique is also illustrated in Fig. 10.

The area enclosed by the hysteresis loops was measured using a polar planimeter. Using this technique, areas could be measured to the nearest 0.01 square inch.

Continuous load-time and strain-time records were obtained with a Gould Brush 2200 two-channel strip chart recorder. Typical traces are shown in Fig. 11.

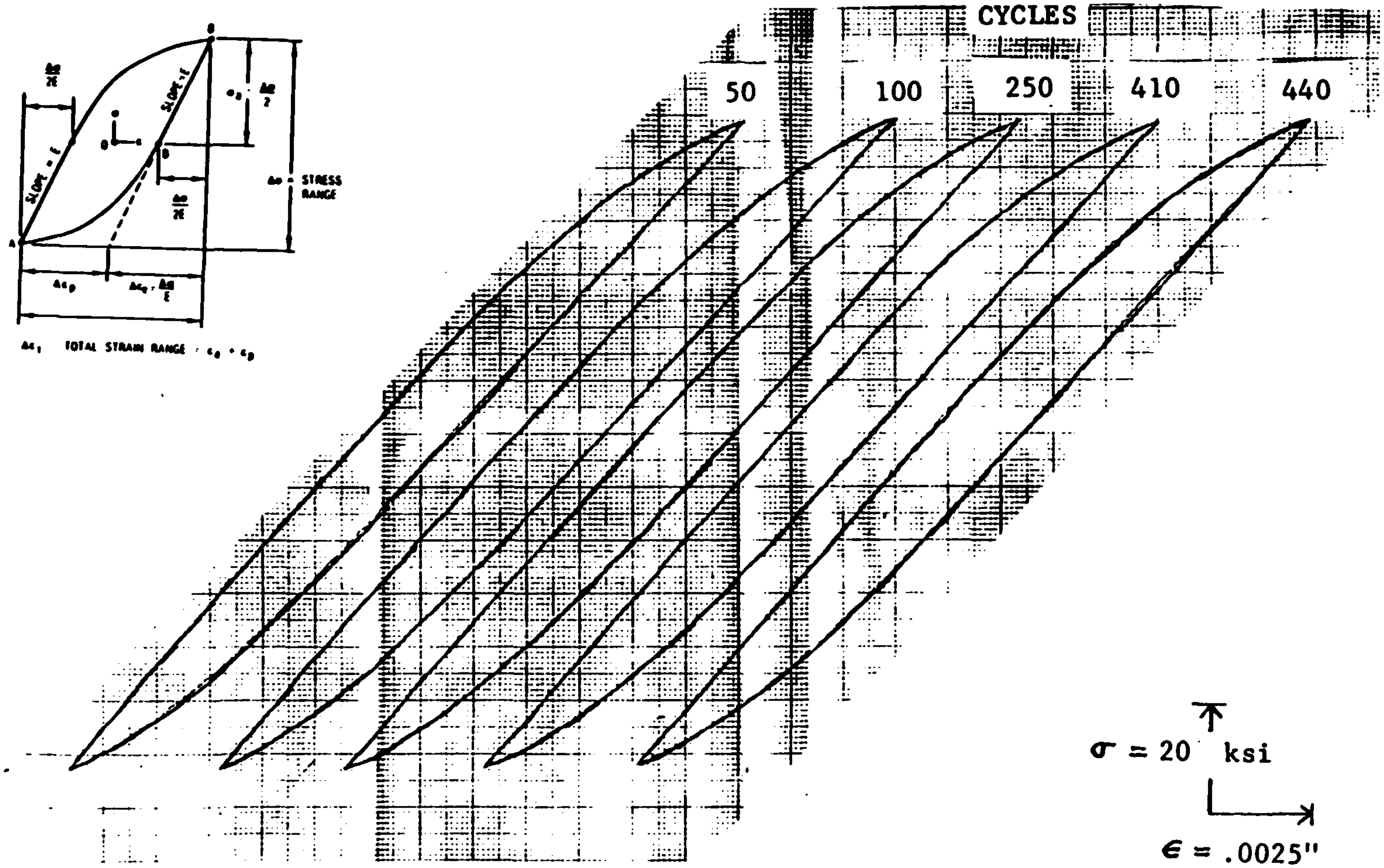


Fig. 10 Typical Stress-Strain Hysteresis Loops Recorded on a Moseley Model 7000A x-y Recorder

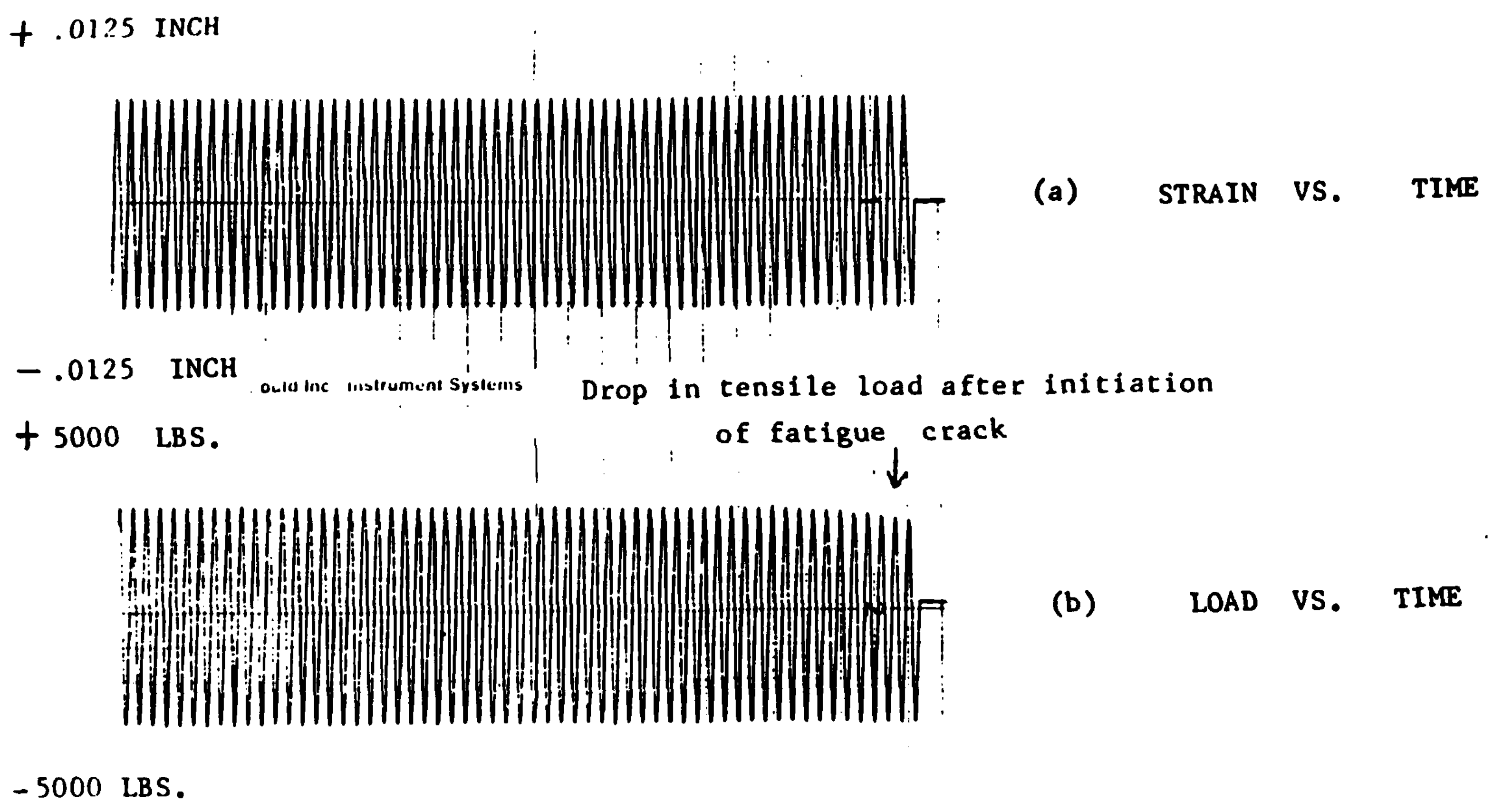


Fig. 11 Typical Load-Time and Strain-Time Traces Obtained with a Gould Brush 2200 Two-Channel Strip Chart Recorder

4.4.2 NDI Monitoring for Crack Detection

Early monitoring of experimental methodology specimens was accomplished with eddy current techniques. These techniques, used in fastener hole inspections, are described in Volume I [3]. For surface inspection, an eddy current pencil probe (NDT Product Engineering, MP-20 micro-probe) was used to inspect for early fatigue cracks in the reduced section of the specimen. Since scanning had to be performed manually instead of automatically, there was some loss of sensitivity. This monitoring was compared to crack detection as observed from the decrease in maximum tensile load with cycling. The decrease in the maximum tensile load, due to load shedding, was found to be more sensitive than eddy current techniques for determining macroscopic crack initiation. Therefore, the load shedding technique was used to determine the TTCI for Tests under Task 5 (Ref. Table 4) for both 7075-T7651 aluminum alloy and beta-annealed Ti-6Al-4V.

In the 7075-T7651 aluminum alloy material, after the first few cycles, the maximum tensile stress remained relatively constant until a fatigue crack was initiated. A calibration curve was established between the decrease in maximum tensile stress and crack depth. After tensile load decreases of different percentages were observed during fatigue testing, specimens were then overloaded in tension to failure. Fatigue crack sizes were then measured. The results are

presented in Appendices A and B. Cycles to crack initiation for test specimens in Task 5 were defined in terms of cycles completed before a 2% drop in maximum tensile stress occurred.

Cyclic softening occurred in the beta-annealed Ti-6Al-4V alloy at higher strain amplitudes. Both the maximum tensile stress and compressive stress decreased as a function of cycling. The percentage decrease in maximum compressive stress was used to measure cyclic softening occurring and thus allowing the effects of "load shedding" and cyclic softening to be separated in the measurements of maximum tensile stress. The onset of a 0.010 inch deep fatigue crack was defind as the number of cycles when the maximum tensile stress showed a 2% greater decrease than the maximum compressive stress.

4.5 DOG-BONE SPECIMEN TESTS

Dog-bone specimens with a center hole were tested in three basic configurations: (1) open hole, (2) bolt in hole but no bolt load transfer and (3) load transferred directly through the bolt to the specimen. All dog-bone specimens tested in Phase II had the same basic specimen design shown in Fig. 3. Details of the dog-bone fatigue tests performed, including test setup, experimental procedures, etc., are described below.

All spectrum fatigue and constant amplitude

stress-controlled tests were performed on servo-controlled hydraulically-actuated load frames. The test setup used for the no bolt load transfer tests is shown in Fig. 12. This setup was used for both constant amplitude and spectrum fatigue tests. Details of the environmental chamber are described in Section 4.3.2.

Specimens for the spectrum fatigue tests were run continuously until failure or to a specified time. Occasional stops were made for testing adjustments, measurements or equipment maintenance/repair.

The test setup for the bolt load transfer tests is shown in Fig. 13. A loading bar with an integral environmental chamber was used to transfer the ram load to the bolt in the center hole of the dog-bone test specimens. Two independent but synchronized rams were used to load the test specimen. One ram applied load directly through the lug and of the specimen while the other ram applied loads directly to the loading bar as shown in Fig. 13. The environmental chamber used is described in Section 4.3.3.

The percentage of load transfer (LT) through the bolt is defined as a percentage of the total applied ram load to the specimen lug end. We used two different percentages of LT for the load transfer tests, i.e., 20% LT and 40% LT.

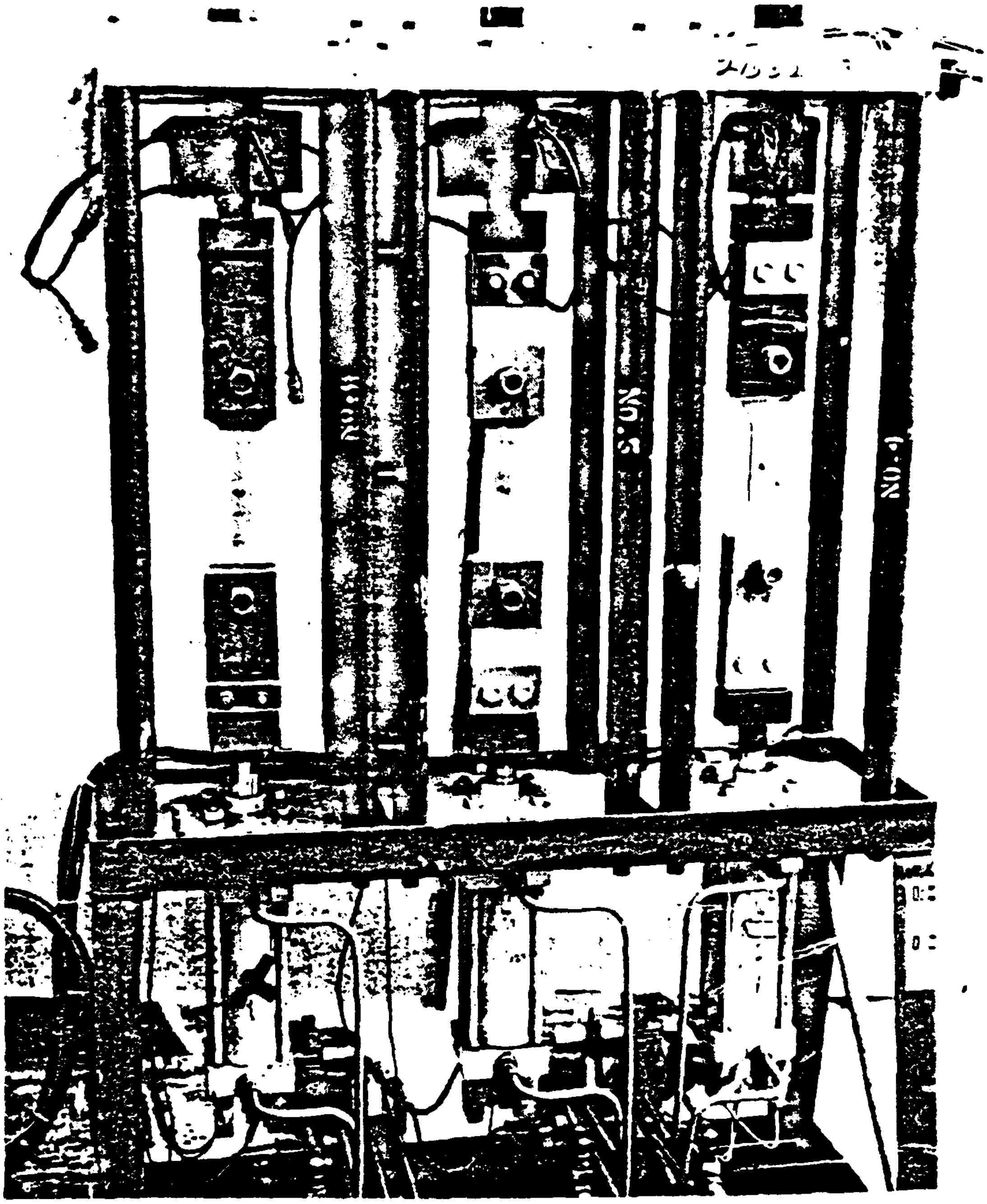


Fig. 12 Test Setup for No-Bolt Load Transfer
Dog-Bone Specimen Tests

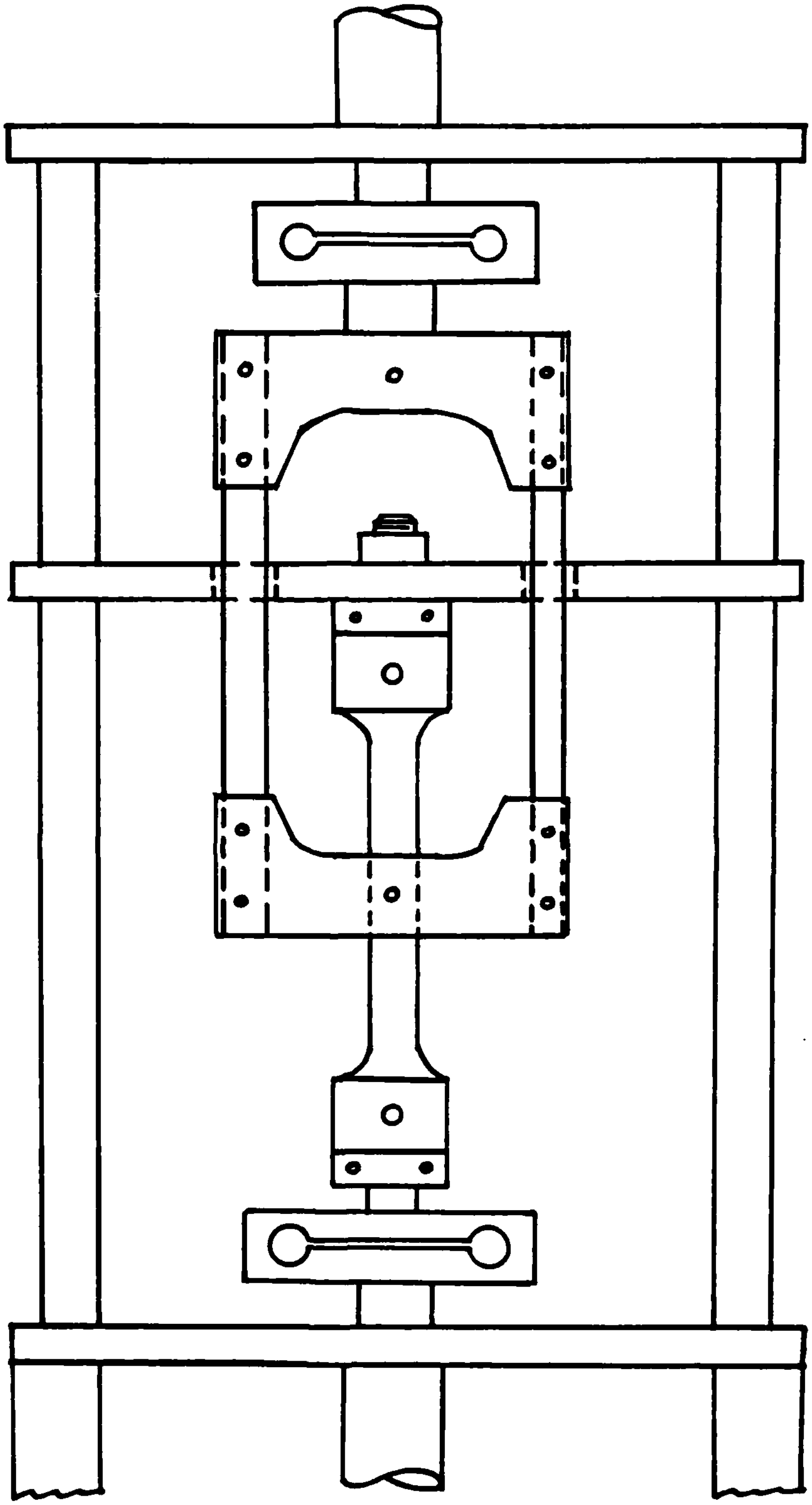


Fig. 13 Test Setup for Bolt Load Transfer Dog-Bone Specimen Tests

A special hardware interface was used for all dog-bone tests to continuously monitor each load frame and to assure proper load control. This system provided a permanent record of test events.

Eddy current measurements were periodically made in the center hole of the test specimen for all constant amplitude tests. Spot check measurements were also made during the spectrum fatigue tests to determine the time to initiate a crack size of 0.01" in the fastener hole. The eddy current probe was inserted directly into the fastener hole without disassemblying the environmental chamber. For the no-load transfer tests the cork in the hole at the side of the environmental chamber was removed to permit eddy current measurements to be made. In the case of the bolt load transfer tests, the bolt through the loading bar and ennvironmental chamber was removed to make eddy current measurments.

The eddy current technique, described in Volume I [3] provided backup information on the TTCI for the spectrum fatigue tests. This technique was used to complement the fractography - particularly for those tests when the 3.5% NaCl environment might affect the fatigue markings on the fracture surface.

4.6 TEST SPECTRA

Three test spectra were considered in the Phase II testing of 7075-T7651 aluminum alloy dog-bone specimens: (1) F-16 400 hour (hi-lo block), (2) F-18 300 hour (random) and (3) F-18 300 hour (hi-lo block).

The F-16 400 hour (hi-lo block) spectrum used for the Phase II testing is a wing-root bending spectrum. This preliminary development spectrum has been used extensively at the General Dynamics, Fort Worth Division for F-16 development tests and other structural research programs [5-7]. We selected this spectrum for use in the Phase II effort because this spectrum marks well fractographically and we have considerable experience in reading the fractographic data. The F-16 400 hour (hi-lo block) spectrum is referred to herein as spectrum "A".

Samples of the load history for the F-16 400 hour spectrum are shown in Fig. 14. A breakdown of the load history by load points for the F-16 400 hour and F-18 300 hour test spectra are compared in Table 11.

The F-18 300 hour spectrum, supplied by the Naval Air Development Center (Warminster, PA) for this program, is a modified wing spectrum. This spectrum was modified for Phase II testing purposes as follows. The maximum compressive load in

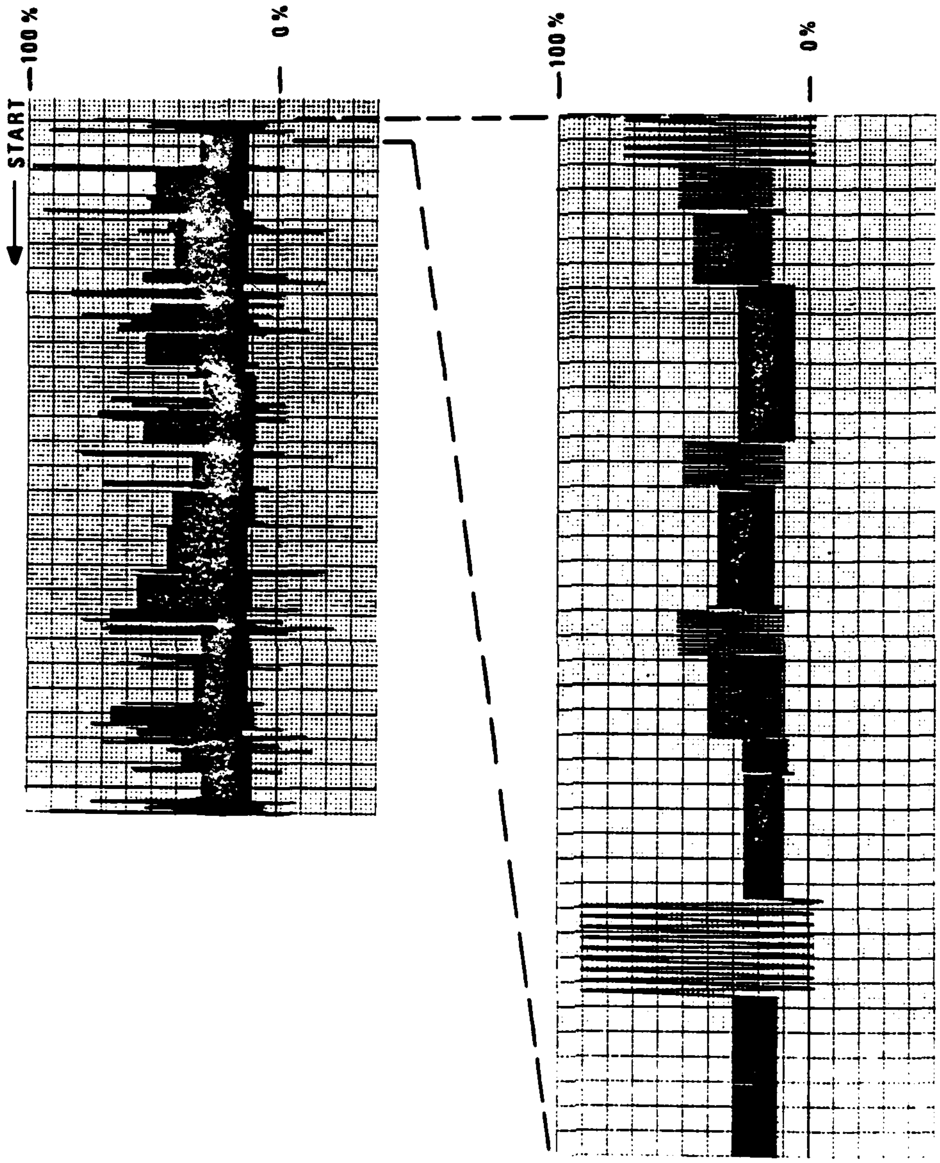


Fig. 14 Samples of the Load History for the F-16 400 Hr. Spectrum

Table 10 Breakdown of Load Points by 5% Intervals for the F-16 400 Hr Block Spectrum

Range in Percent		Spectrum Johns II 400 Hr. F-16 765747 LP Total (8000 Flt Hrs)
Min	Max	Load Pts. in Range
-30.1	-35.0	60
-25.1	-30.0	0
-20.1	-25.0	60
-15.1	-20.0	80
-10.1	-15.0	200
-5.1	-10.0	440
-0.1	-5.0	3684
0	at zero 0	10187
0.1	5.0	2880
5.1	10.0	59360
10.1	15.0	312566
15.1	20.0	920
20.1	25.0	3780
25.1	30.0	81300
30.1	35.0	100222
35.1	40.0	39024
40.1	45.0	66050
45.1	50.0	16526
50.1	55.0	35585
55.1	60.0	18770
60.1	65.0	1700
65.1	70.0	8980
70.1	75.0	1950
75.1	80.0	551
80.1	85.0	640
85.1	90.0	0
90.1	95.0	208
95.1	100.0	24

TABLE 11 COMPARISONS OF F-16 400 HOUR AND F-18 300 HOUR TEST SPECTRA

Spectrum I.D.	No. Flt. Hrs. Per Block	Service Life (Flt Hrs)	No. Load Points for		
			Block	Flt Hrs	Service Life
F-16 400 Hr	400	8000	38287	95.718	765747
F-18 300 Hr	300	6000	3137	10.457	62740

Note: The maximum gross stress on test specimen cross section scaled to maximum load in each spectra.

the spectrum was limited to the same percentage of the maximum tension load as that for the F-16 400 hour spectrum (i.e., 35% of maximum tension load). This modification of the F-18 300 hour spectrum was made so that the dog-bone specimens could be fatigue tested in load frames without special lateral support required.

Two variations of the F-18 300 hour spectrum were considered: (1) loads randomized for each 300 hour block and (2) loads ordered in the same sequence for each 300 hour block (hi-lo). The first spectrum variation is referred to herein as the "F-18 300 hour (randomized)" spectrum or spectrum "B" and the second variation is referred to as the "F-18 300 hour (Hi-lo block)" spectrum or spectrum "C". The hi-lo block version of the F-18 300 hour spectrum was formatted the same way as the F-16 400 hour (hi-lo block) spectrum.

Strip chart printouts of the load history for spectrum B and C are shown in Fig. 15 and 16, respectively.

4.7 FRACTOGRAPHIC ANALYSIS

4.7.1 General Procedure

Dog-bone fatigue specimens were prepared for fractographic evaluation as follows. Unbroken specimens were first broken open to display the fracture surface. All

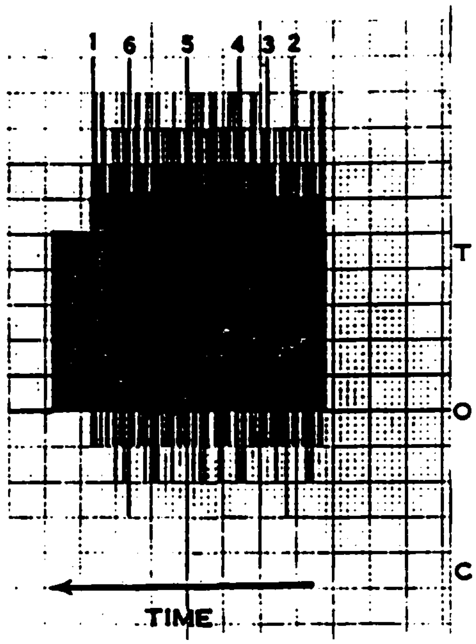


Fig. 15 Strip Chart Trace of Load History for F-18 300 Hour (Random) Spectrum ("B")

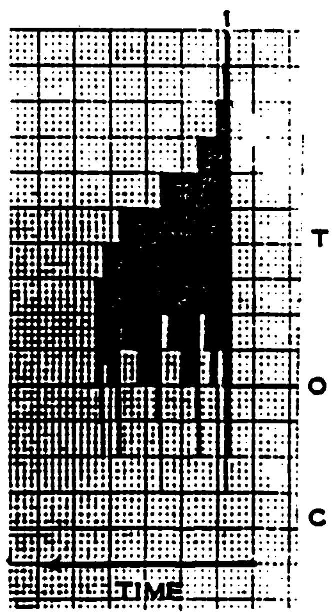


Fig. 16 Strip Chart Trace of Load History for F-18 300 Hour (Block) Spectrum ("C")

fracture surfaces were then cleaned to prepare the specimens for fractographic analysis. All shear lips were ground off without damaging the fracture surface. Specimens were then cleaned ultrasonically in acetone. A cellulose-acetate tape was softened using acetone and then pressed firmly against the fracture surface to remove surface dirt or residue. This cleaning process was repeated several times for best results.

After thoroughly cleaning the fracture surface, the fracture specimen was then mounted onto the microscope stage using a piece of clay to hold it in place. A fractographic evaluation was performed then for the largest fatigue crack in each fastener hole. The final size of the fatigue crack on each size of the fastener hole was measured and results were recorded on the fratographic data sheets (e.g., ref. Appendices D-F).

Fractographic evaluation were made using an X, Y micrometer stage with a bench stereo microscope at magnifications of 15X to 120X. The number of load points at specimen failure were translated into the bench marks at failure using the applicable load spectra. Fractographic measurements were then taken at the end of each block back to a minimum crack size of 0.010", where possible. In some cases, fractographic measurements could not be traced to the desired minimum crack size due to poor surface markings for

the smaller crack sizes. The fractography provided the means for defining the time-to-crack-initiation (TTCF) for a_0 = 0.01" in the fastener holes.

Crack size versus time measurements and other pertinent details were recorded on the fractographic data sheets. This includes, in most cases, a photograph of the fracture surface, specimen dimensions, crack origins, peculiarities, number of load points at failure, etc.

Sample fractographic surfaces are shown in Fig. 17 with crack growth markers corresponding to loads $\geq$ 80% of the maximum load in the F-16 400 hour spectrum ("A"). Similarly, sample fractographic surfaces with crack growth markers corresponding to loads $\geq$90% of the maximum spectrum load are shown in Figs. 18(a) and 18(b) for the F-18 300 hour (random) spectrum ("B") and the F-18 300 hour (block) spectrum ("C"), respectively.

4.7.2 Crack Initiation Origins

Following fatigue testing, each failed specimen was carefully examined to determine, if possible, the primary origin of failure. Many specimens had multiple crack origins making failure analysis difficult.

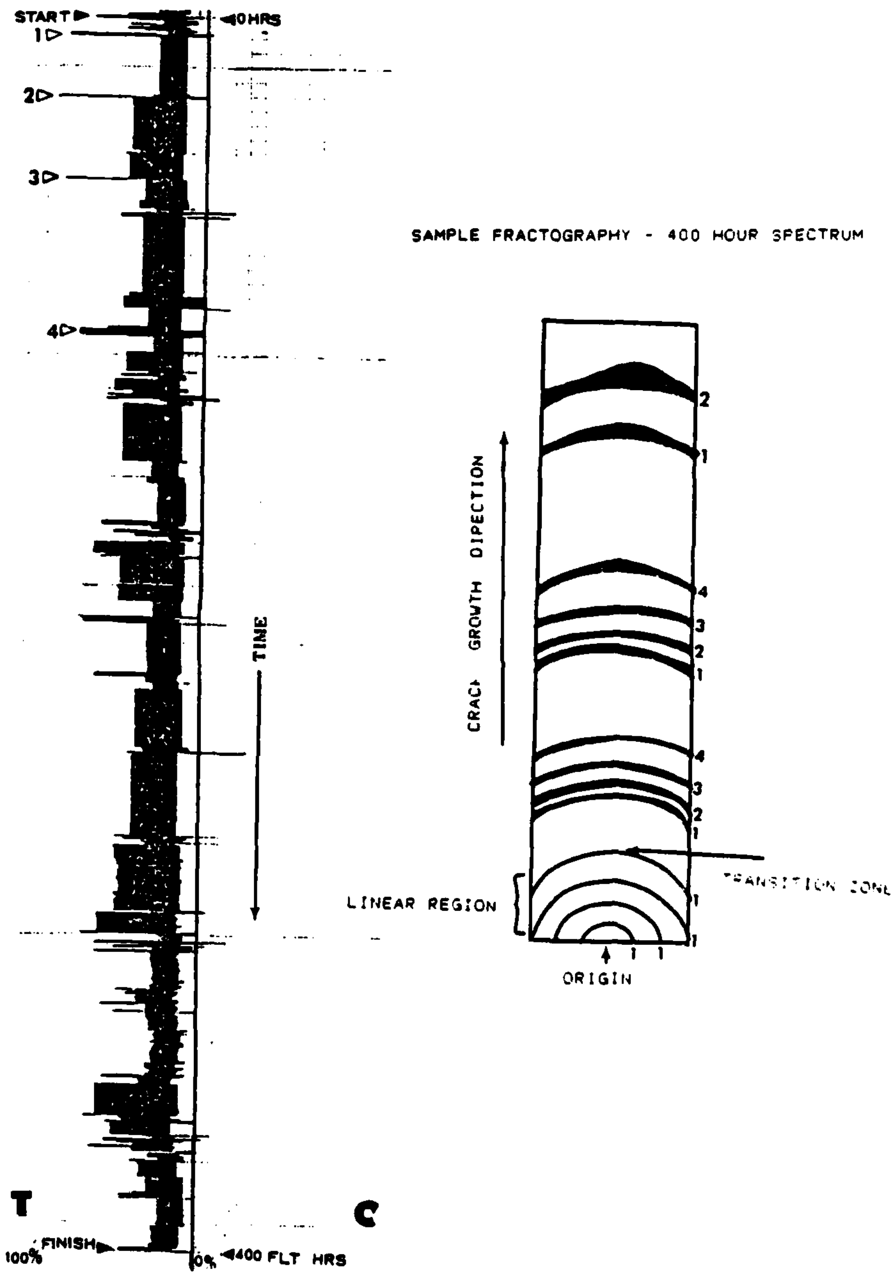
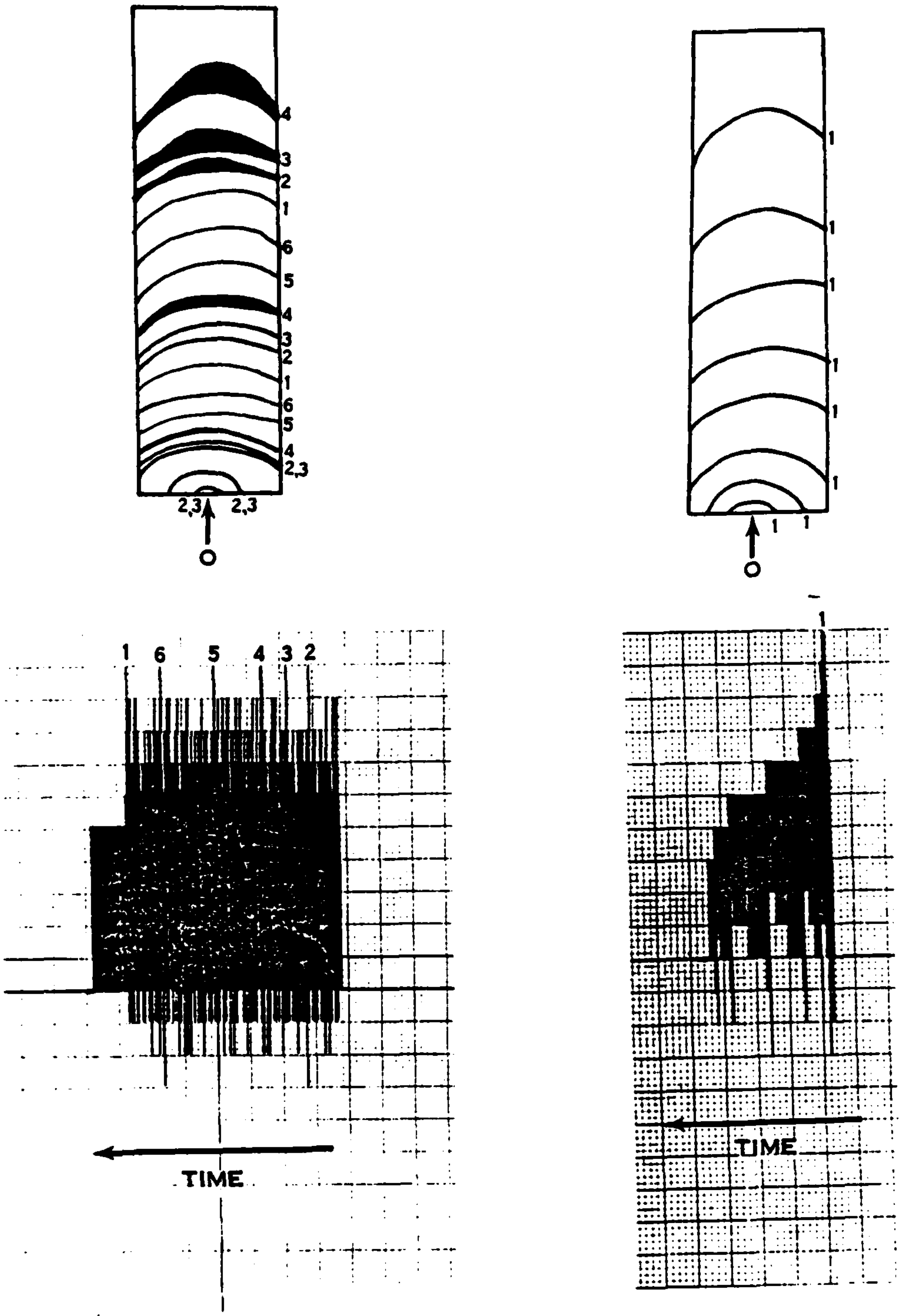


Fig. 17 Sample Crack Growth Markers Corresponding to 80% + Loads for F-16 400 Hours Spectrum ("A")



(a) (b)

Fig. 18 Sample Crack Growth Markers Corresponding to 90% + Loads for F-18 300 Hour Spectrum: (a) Random Spectrum ("B"); (b) Block Spectrum ("C")

Fatigue crack origins were cataloged as follows: B = bore of hole, C = corner of hole, S = surface away from hole and I = internal flaw. Results are presented in Appendices D-F.

4.8 EXTRAPOLATION OF FRACTOGRAPHIC RESULTS

In some cases, the fractography could not be reliably read down to the selected reference crack size for time-to-crack-initiation (i.e, a_0 = 0.010") for the dog-bone specimens. In such cases, the fractographic results were extrapolated to estimate the time-to-crack initiation (TTCI).

Three different extrapolation methods were considered to estimate the TTCI for a_0 = 0.01": (1) linear extrapolation, (2) least squares fit of power law and (3) least squares fit of exponential function. Extrapolations were estimated for each of the three methods and the results were compared for consistency.

Linear extrapolations were based on the two smallest consecutive crack sizes that could be fractographically read. Extrapolations based on the assumed power law and exponential functions were determined using a least squares fit form of

Eqs. 1 and 2 to the three smallest consecutive crack sizes shown on the fractographic data sheet, respectively.

$$a(t) = At^B \tag{1}$$

$$a(t) = \hat{a}(0)\ \exp\ (Qt) \tag{2}$$

In Eqs. 1 and 2, a(t) is the crack size at any time t; A, B, a(0) and Q are empirical constants. The applicable constants were determined using the least square fit form of Eqs. 1 and 2 given by Eqs. 3 and 4, respectively.

$$\underbrace{\ell n\ a(t)}_{Y} = \underbrace{\ell n\ a}_{b} + \underbrace{B}_{m}\ \underbrace{\ell n\ t}_{X} \tag{3}$$

$$\underbrace{\ell n\ a(t)}_{Y} = \underbrace{\ell n\ \hat{a}(0)}_{b'} + \underbrace{Q}\underbrace{t}_{mX} \tag{4}$$

APPENDIX A
STRAIN-CONTROLLED TEST RESULTS FOR 7075-T7651 ALUMINUM ALLOY

A.1 INTRODUCTION

Raw test results for Tasks 4 and 5 are presented in this Appendix. These results are evaluated and discussed in Volume III [1].

A.2 TASK 4 TEST RESULTS

Task 4 was concerned with the development of experimental methodology for requiring strain-controlled data for dry air and 3.5% Nacl environments. The strain-controlled data is needed to implement the strain life approach for making time-to-crack-initiation (TTCI) predictions for mechanically-fastened joints. Details of the strain life approach are discussed in Volumes I [3] and III [1]. Results from the Task 4 effort are presented herein.

A.2.1 Stress Strain Hysteresis

Typical behavior of the stress-stain hysteresis plots are shown in Fig. A1. A slight drop in the maximum tensile and compressive stresses occurred during the first few cycles followed by stable behavior after approximately 25 cycles.

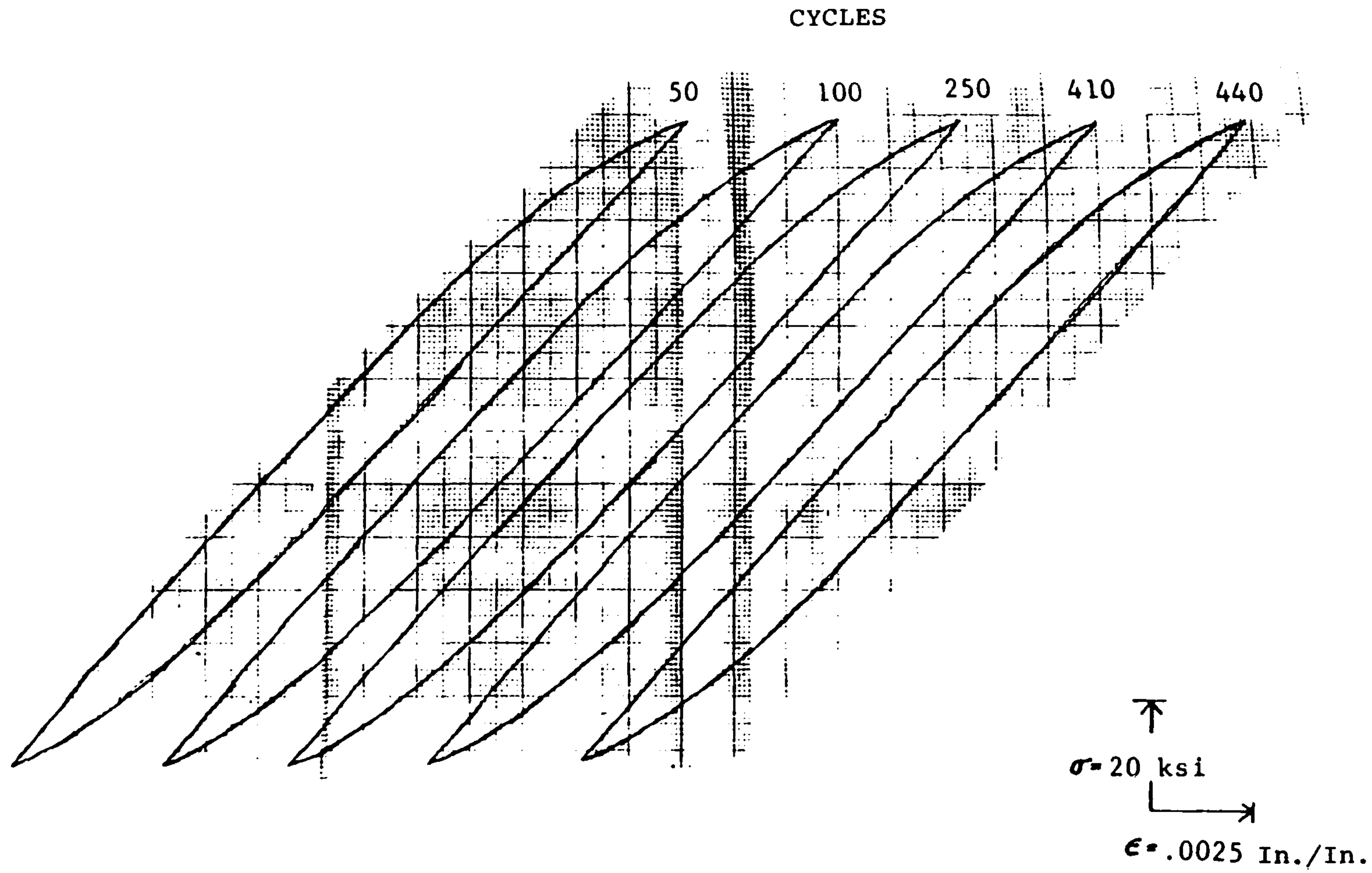


Fig. A1 Stress-Strain Hysteresis Loops During Fatigue Cycling.

A.2.2 Strain Survey

Strain surveys were performed to experimentally quantify the relationship between ram load, axial strain and axial deformation (over 2.00" gage length). Four axial strain gages and an extensometer were mounted on the calibration specimen as shown in Figs. 9 and 10.

Strain survey results are presented in Table A1. Axial load versus axial strain results are plotted in Fig. A2. In Fig. A3 the axial load versus axial deformation is plotted. The relationship between strain at the neck-down area and the constant diameter area is shown in Fig. A4. The axial load versus axial strain relationship obtained is plotted in Fig. A5.

A.2.3 Specimen Calibration and Load Shedding Results

Plots for the maximum tensile load versus number of cycles and the maximum tensile stress versus number of cycles are shown in Figs. A6 and A7, respectively. Results are shown in Fig. A6 for three specimens immersed in 3.5% NaCl solution. In Fig. A7, results are plotted for specimens have total strain amplitudes ranging from $\Delta\epsilon_T/2$ = 0.65% to $\Delta\epsilon_T/2$ = 1.70%. In general, very little change in compressive or tensile loads was observed until a

Table A1 Strain Survey Results for Strain-Controlled Specimen

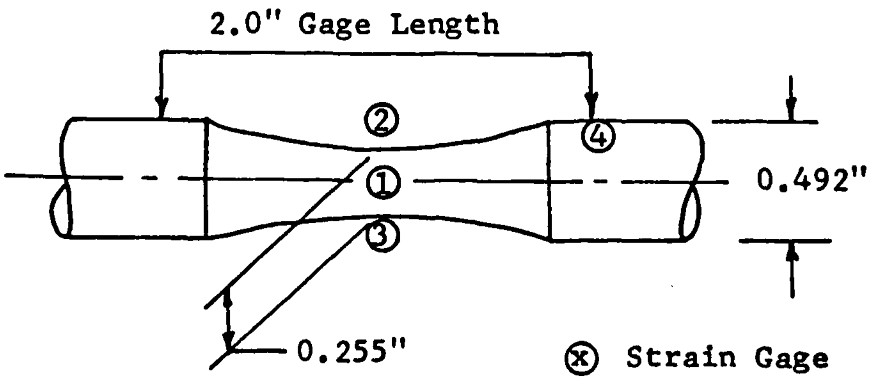
Load	P/A_1	Extensometer Volts**	Extensometer In	$\varepsilon 1$	$\varepsilon 2$	$\varepsilon 3$	Ave. ε_{1-3}	$\varepsilon 4$	Ave. $\varepsilon_{1-3}/\varepsilon_4$
				←	10^3	in/in		→	
0	0	-	-	0	0	0	0	0	0
80	1567	-	-	.147	.154	.146	.149	.044	3.386
120	2351	.06	.0003	.218	.228	.215	.220	.065	3.385
200	3918	.10	.0005	.369	.389	.370	.376	.110	3.418
300	5877	.15	.00075	.551	.582	.555	.563	.164	3.433
500	9795	.23	.00115	.920	.966	.920	.935	.273	3.425
700	13713	.32	.0016	1.294	1.364	1.302	1.320	.388	3.402
1000	19591	.45	.00225	1.845	1.942	1.854	1.880	.552	3.406
1200	23509	.54	.0027	2.221	2.338	2.230	2.263	.663	3.413
1400	27427	.63	.00315	2.594	2.726	2.599	2.639	.773	3.414
1600	31345	.72	.0036	2.977	3.129	2.987	3.031	.885	3.425
1800	35263	.82	.0041	3.360	3.527	3.370	3.415	.996	3.429
2000	39181	.91	.00455	3.746	3.931	3.756	3.811	-	-
0	0	-	-	-	-	-	-	-	-
1000	19591	.46	.0023	1.900	1.995	1.897	1.931	.574	3.364
2000	39181	.92	.0046	3.803	3.987	3.821	3.870	1.131	3.422
2200	43099	1.02	.0051	4.190	4.386	4.200	4.259	1.236	3.446
2400	47018	1.11	.00555	4.582	4.791	4.598	4.657	1.348	3.455
2600	50936	1.21	.00605	5.016	5.234	5.056	5.102	1.466	3.480
2800	54854	1.30	.0065	5.513	5.684	5.608	5.602	1.572	3.564
3000	58772	1.40	.0070	6.115*	6.194*	6.330*	6.213	1.694	3.668
3100	60731	1.46	.0073	6.560	6.514	6.909	6.661	1.745	3.817
3200	62690	1.80	.0090	12.089	11.532	12.205	11.942	1.819	6.565
0	0	.28	.0014	5.633	4.752	5.719	5.368	.042	127.80

Notes: * Creep Observed

Extensometer Readings: 20 Volts = 0.10"

** ± 0.02 Volts

$A_1 = 0.785(0.255)^2 = 0.05104 \text{ in.}^2$



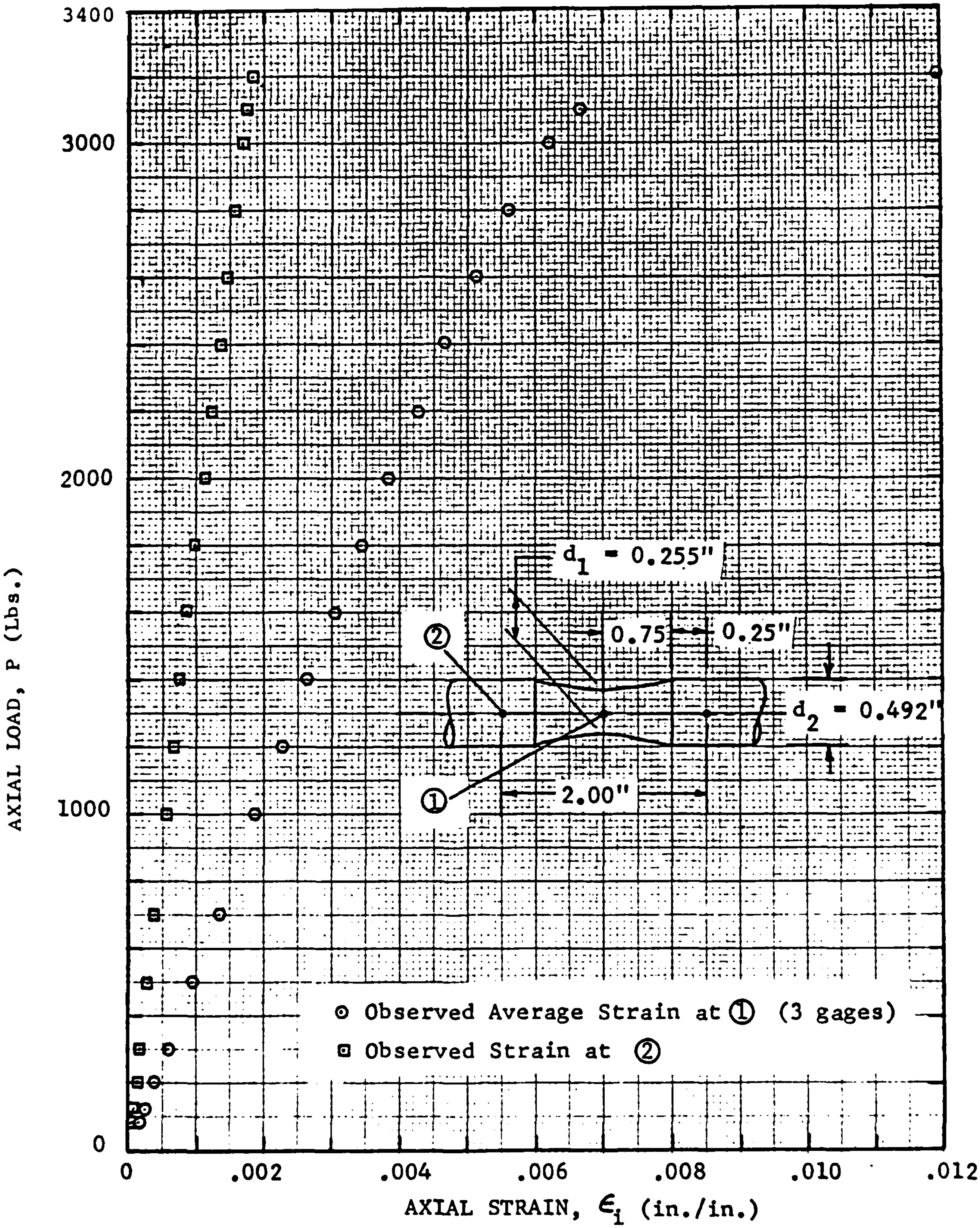


Fig. A2 Axial Strain Versus Axial Load For Strain-Controlled Specimen (7075-T7651)

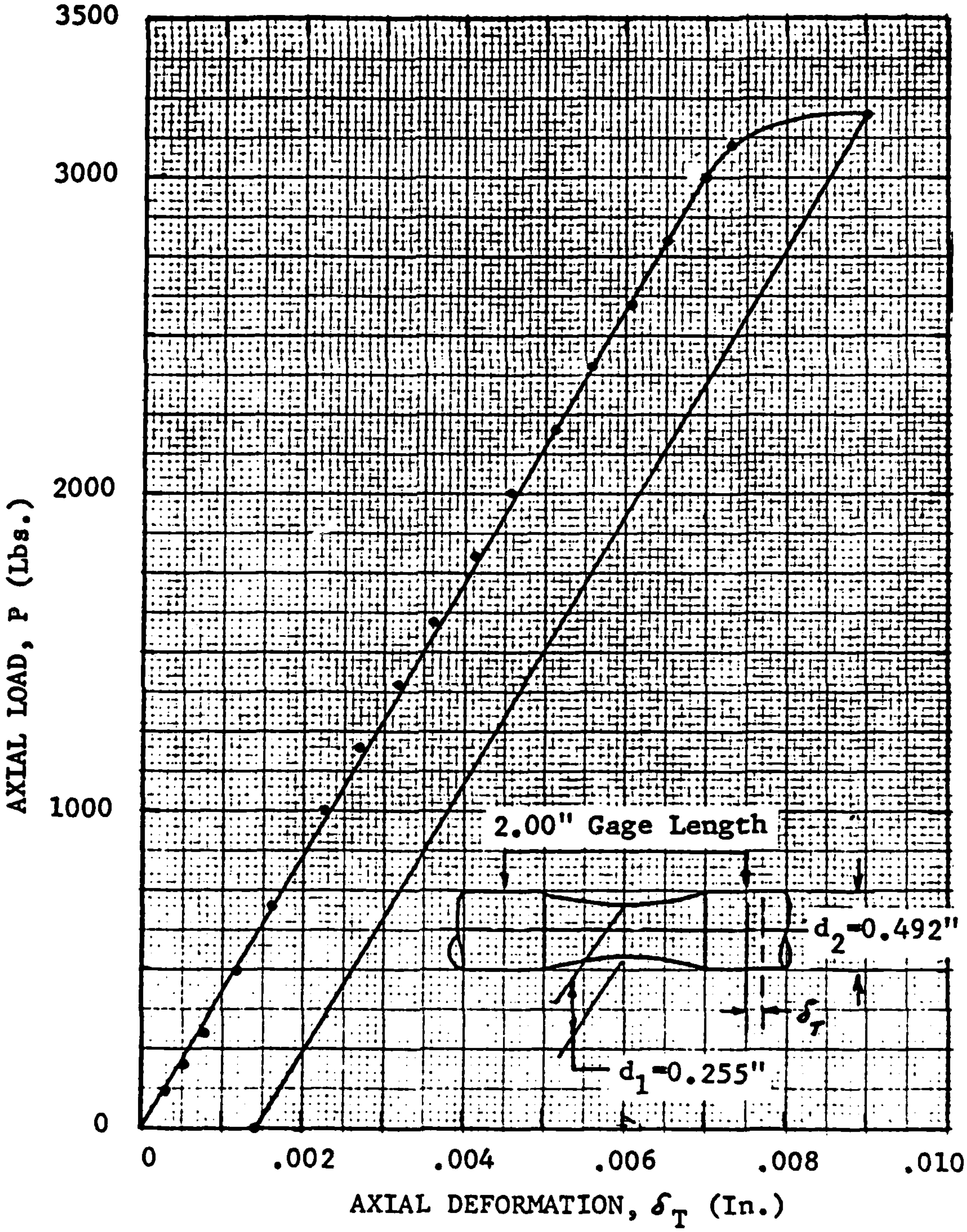


Fig. A3 Axial Deformation Versus Axial Load For Strain-Controlled Specimen (7075-T7651)

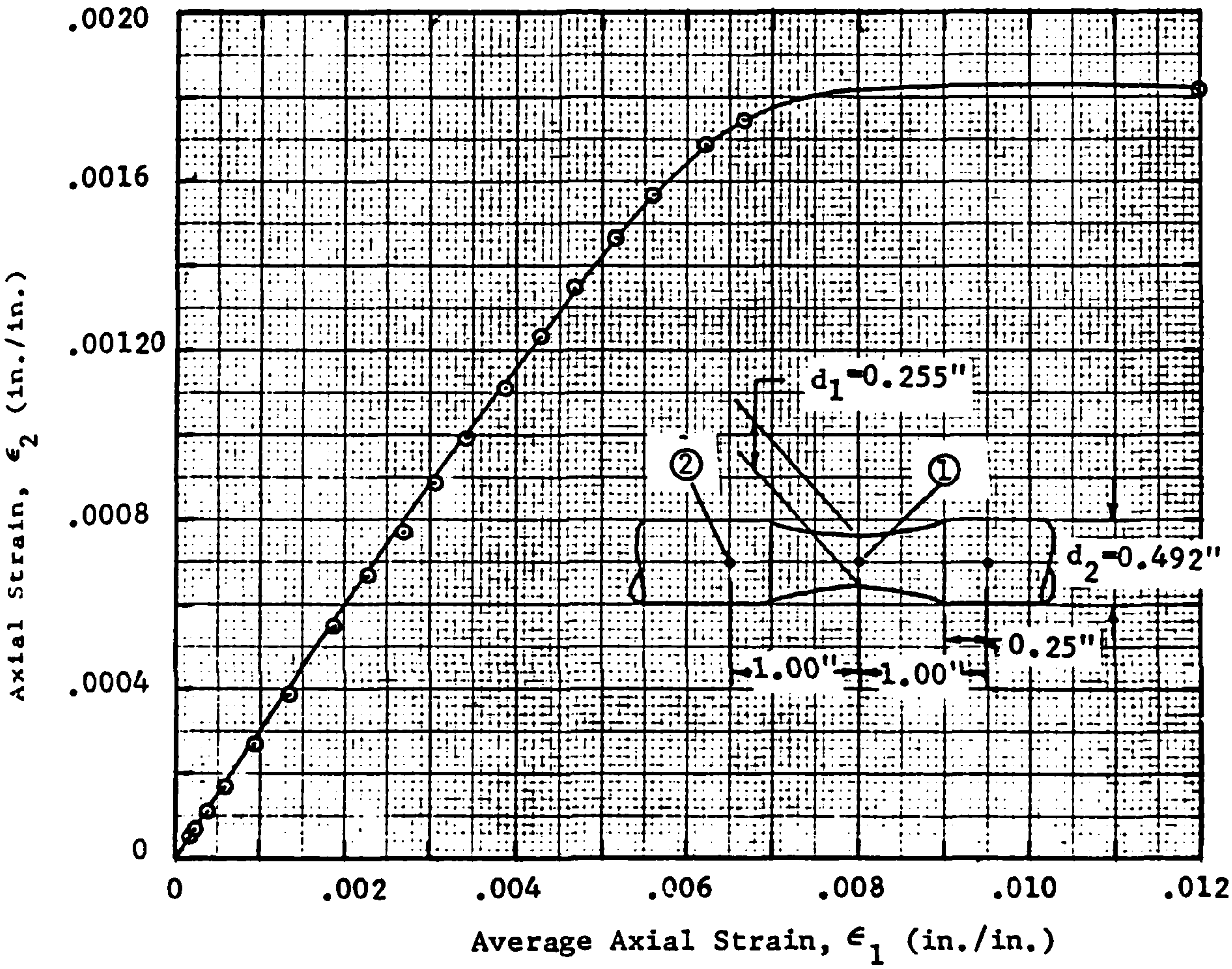


Fig. A4 Axial Strain Relationships For Strain-Controlled Specimen (7075-T7651)

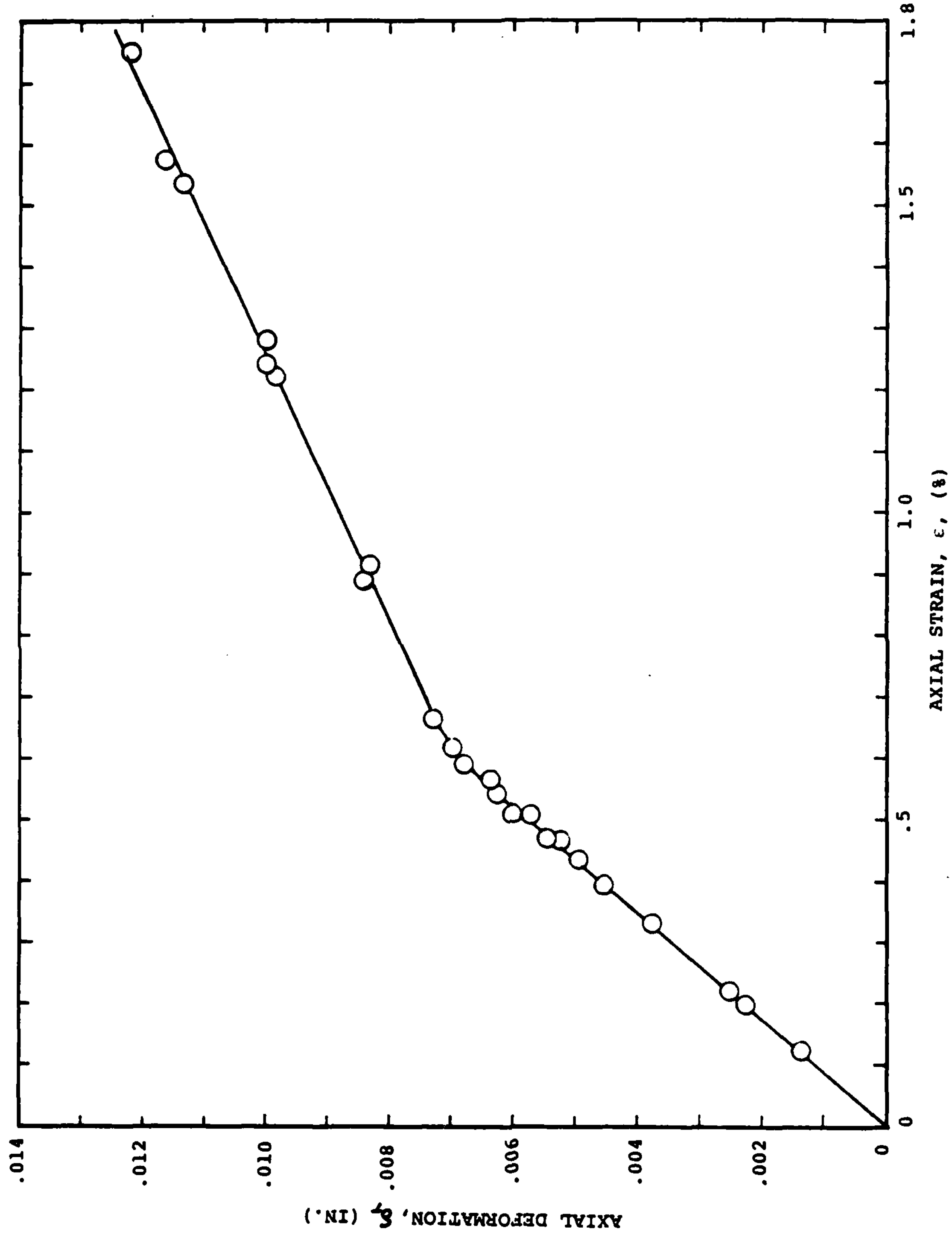


Fig. A5 Axial Deformation Versus Axial/Strain for Strain-Controlled Specimens (7075-T7651 Aluminum)

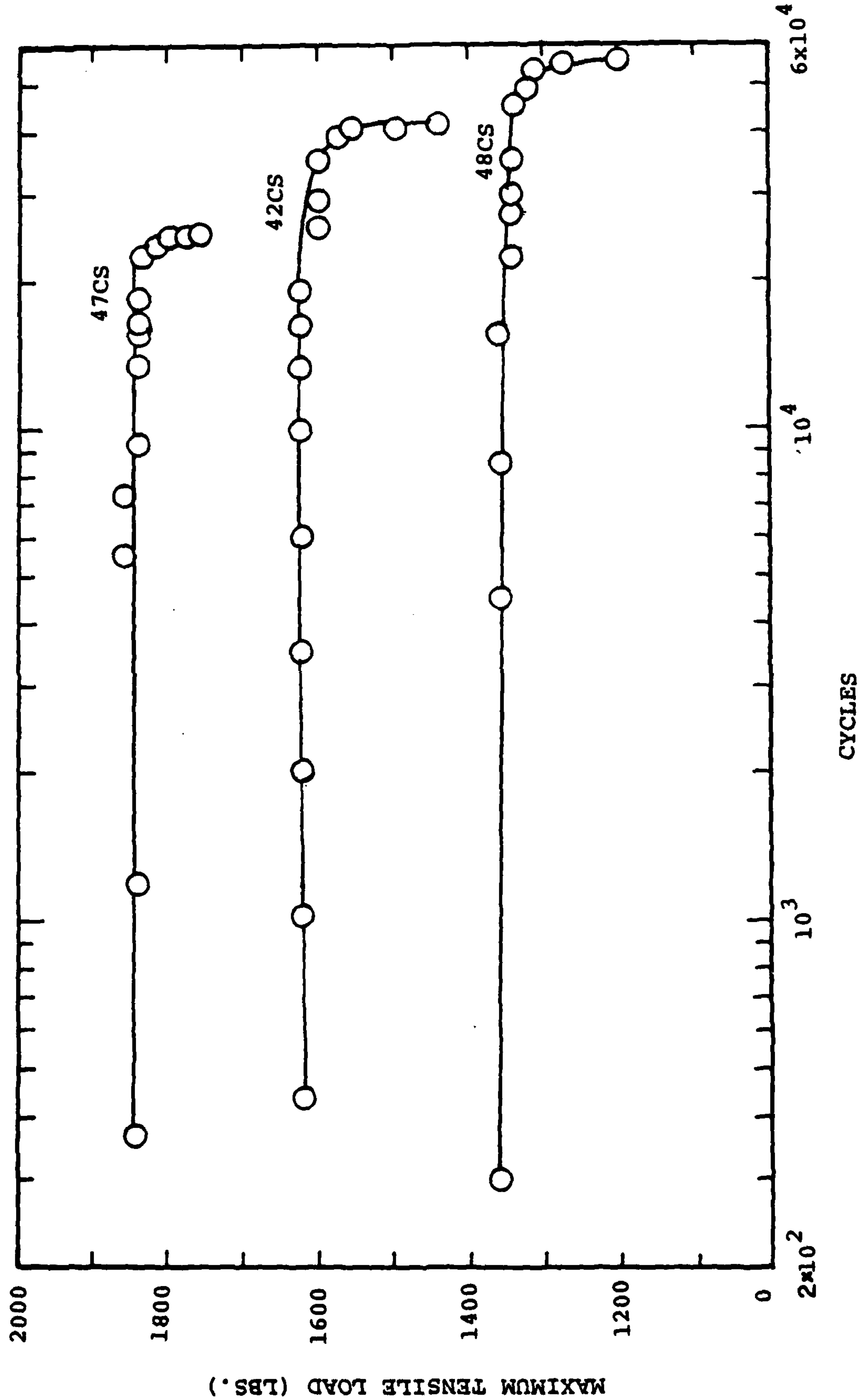


Fig. A6 Maximum Tensile Load as a Function of Fatigue Cycling (Specimens 47CS, 42CS, and 48CS; 7075-T7651 Aluminum)

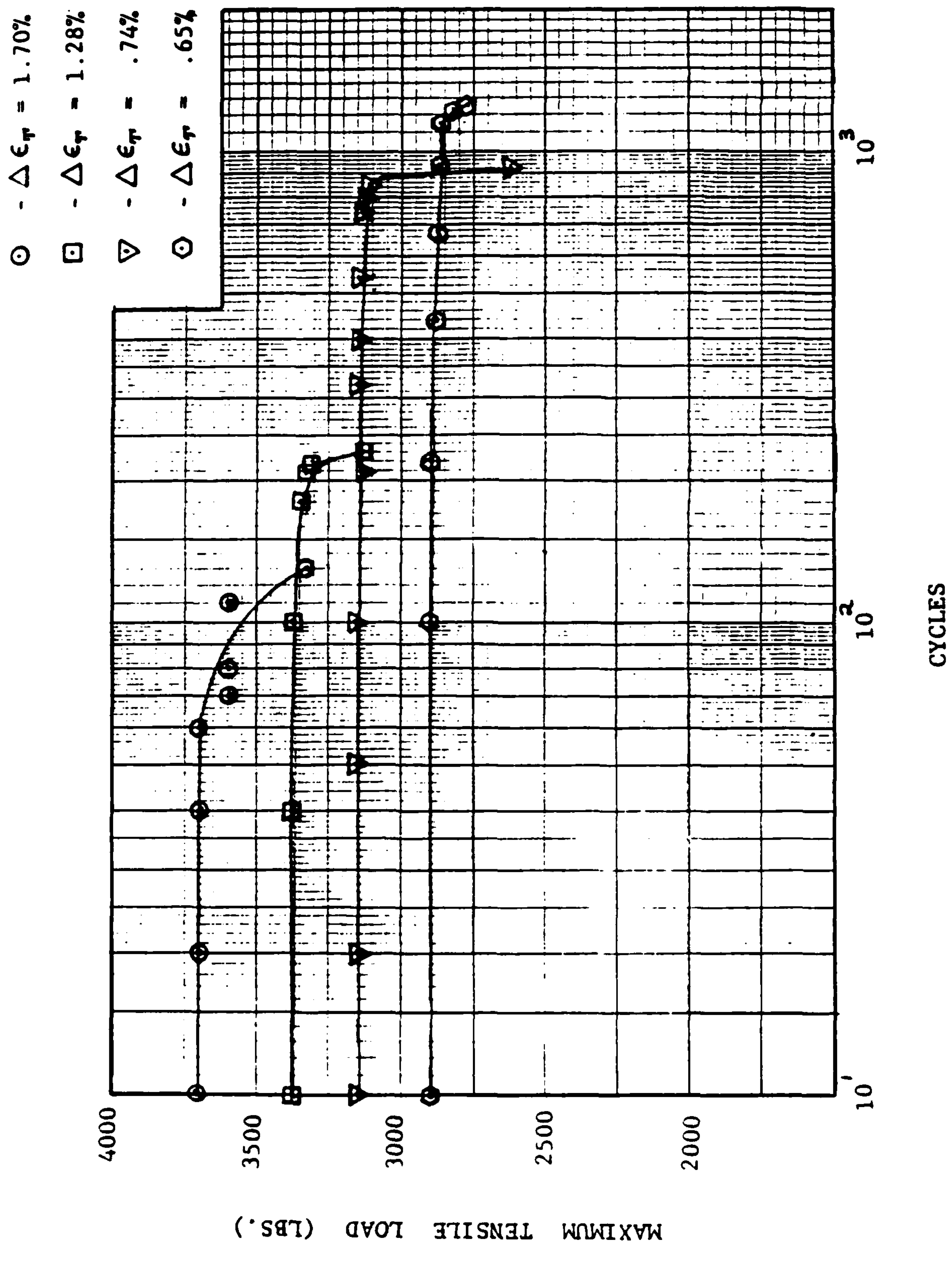


Fig. A7 Maximum Tensile Load As A Function Of Fatigue Cycling For Four Different Total Strain Levels

fatigue crack had initiated. Compressive and tensile loads were relatively stable for both low and high strain amplitude specimens until crack initiation occurred (Fig. A7). Once a fatigue crack had formed, the tensile load dropped rapidly while the compressive load stayed relatively constant. The fatigue crack allows a crack opening displacement to meet the required strain limit with a smaller tensile load. In compression, larger loads were required to strain the material to the required value. Little difference was observed in the behavior of specimens tested at different total strain levels.

A calibration curve was established between the decrease in maximum tensile stress and crack depth. After tensile stress decreases of different percentages were observed, specimens were loaded to failure. Fatigue crack sizes were then measured. The results of these tests are shown in Fig. A8. Cycles to crack initiation for test coupons in Task 5 were defined in terms of cycles completed before a 2% drop in maximum tensile stress occurred. From Fig. A8, a 2% decrease corresponds to a 0.010 inch fatigue crack. This is the same crack size used to define the number of cycles to initiate a crack depth of 0.010", Ni, for the stress-controlled tests of Phase I [3].

A.3 TASK 5 TEST RESULTS

Using the experimental procedures developed and evaluated under Task 4, the required strain-controlled data for Task 5 was

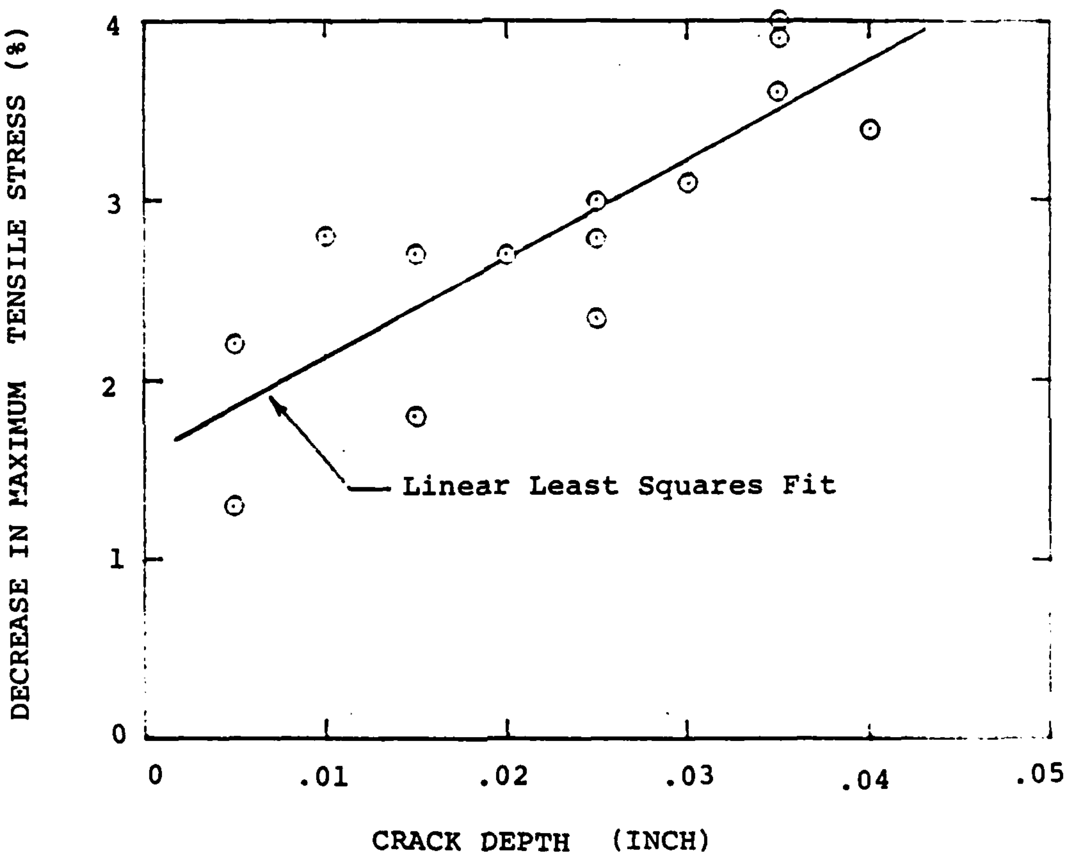


Fig. A8 Decrease in Maximum Tensile Stress as a Function of Crack Size in Strain-Controlled Specimens (7075-T7651 Aluminum)

obtained. The experimental data acquired under Task 5 provided the information needed to make time-to-crack-initiation predictions for mechanically-fastened joints under Task 6. Results presented herein are evaluated in Volume III [1].

Strain-controlled results for Task 5 are shown in Tables A2 and A3 for dry air/lab air and for 3.5% NaCl environments, respectively. Results are presented for: strain amplitude (total, elastic and plastic), area under the hysteresis loop, load frequency, and 2Ni cycles to initiate a crack depth of 0.010 inch.

A plot of cyclic strain versus initiation life in 7075-T7651 aluminum is shown in Fig. A9 for dry air and a 3.5% NaCl environment.

The possible effect of test frequency on crack initation in a 3.5% NaCl environment was examined. Most of these studies were conducted at lower strain amplitudes where the test coupons were exposed to a salt water environment longer. Four frequencies were used: .1 Hz, .5 Hz, 2.0 Hz, and 5.0 Hz. Test results are shown in Fig. A10 and results are evaluated in Volume III [1].

Table A2 Strain-Controlled Test Results for 7075-T7651 Aluminum in Dry Air and Lab Air Environments

Specimen No.	Total Strain Amp (%)	Total Elastic Strain Amp (%)	Total Plastic Strain Amp (%)	Area under Hysteresis Loop (In^2)	Freq. (Hz.)	$2N_f$ (cycles)	Environmental Condition
40CS	.37	.370	-	-	5	183,200	Dry Air
12CS	.42	.420	-	-	2	57,660	Dry Air
6CS	.42	.420	-	-	2	55,400	Lab Air
39CS	.50	.496	-	-	5	23,600	Dry Air
29CS	.51	.510	-	-	.5	18,800	"
31CS	.53	.530	-	-	2	14,000	"
20CS	.52	.520	-	-	2	13,600	"
7CS	.60	.594	.006	.25	.5	8,380	"
37CS	.67	.658	.012	.45	.5	3,820	"
43CS	.71	.680	.030	1.45	.5	1,760	"
17CS	.74	.690	.050	2.30	.5	1,800	"
21CS	.89	.786	.104	3.64	.5	920	"
46CS	.90	.803	.097	3.92	.5	860	"
51CS	.90	.788	.112	4.04	.1	860	"
28CS	.98	.802	.178	6.69	5	700	"
13CS	1.04	.860	.180	5.20	.5	680	"
18CS	1.28	1.003	.277	9.80	.5	420	"
8CS	1.14	.907	.233	8.82	.5	420	"
4CS	1.35	.955	.395	10.90	.5	300	Lab Air
24CS	1.63	1.117	.513	16.88	.5	200	Dry Air
19CS	1.70	1.164	.596	18.78	.5	220	Lab Air
52CS	2.02	1.210	.810	24.63	.5	110	Dry Air

Table A3 Strain-Controlled Test Results for 7075-T7651 Aluminum in 3.5% NaCl Solution

Specimen No.	Total Strain Amp. (%)	Total Strain Elastic Amp (%)	Total Strain Plastic Amp (%)	Area under Hysteresis Loop (In^2)	Freq. (Hz)	$2N_f$ (cycles)	Environmental Condition
49CS	.27	.270	-	-	5	213,000	3.5% NaCl
48CS	.29	.290	-	-	5	109,060	"
42CS	.31	.310	-	-	5	81,120	"
38CS	.33	.330	-	-	2	66,700	"
47CS	.37	.370	-	-	5	49,260	"
34CS	.38	.380	-	-	2	43,680	"
30CS	.37	.370	-	-	2	33,660	"
11CS	.43	.430	-	-	2	38,100	"
15CS	.43	.430	-	-	.5	22,080	"
35CS	.45	.450	-	-	2	16,740	"
22CS	.52	.520	-	-	2	9,740	"
32CS	.52	.519	.001	.05	.5	9,160	"
33CS	.53	.527	.003	.12	5	7,020	"
9CS	.59	.583	.007	.22	.5	3,820	"
16CS	.65	.635	.015	.52	2	2,280	"
44CS	.66	.631	.029	1.15	.5	1,380	"
36CS	.86	.792	.068	2.72	.5	850	"
45CS	.90	.795	.105	4.12	.1	640	"
23CS	.89	.786	.104	3.61	.5	580	"
14CS	.98	.818	.162	5.93	.5	480	"
10CS	1.25	.950	.300	9.82	.5	300	"
26CS	1.63	1.136	.490	16.98	.5	140	"
41CS	2.02	1.220	.800	24.58	.5	88	"

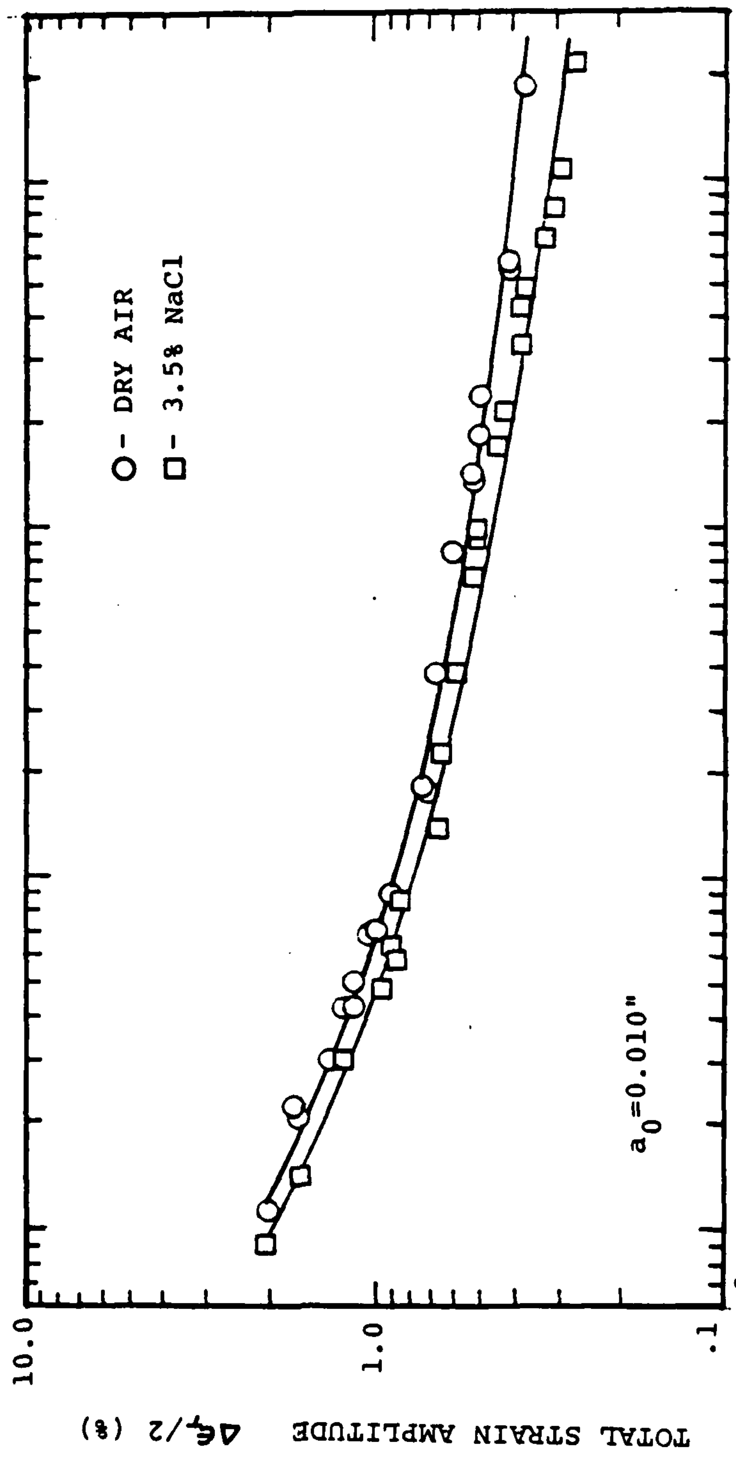


Fig. A9 Total Strain Amplitude Versus Reversals to Crack Initiation for 7075-T7651 Aluminum in Both Dry Air and 3.5% NaCl Environments

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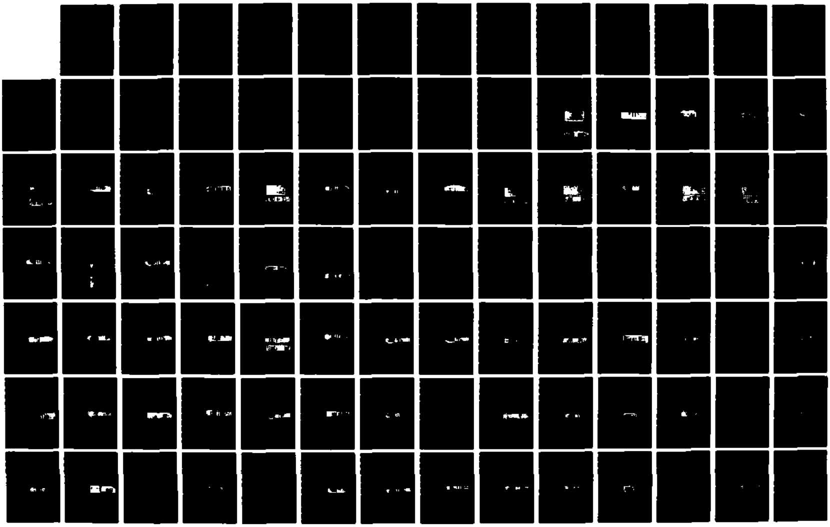

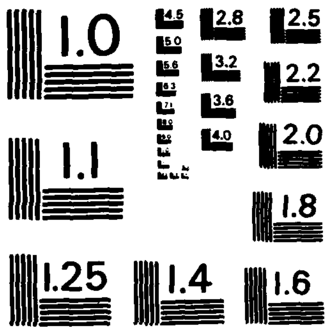

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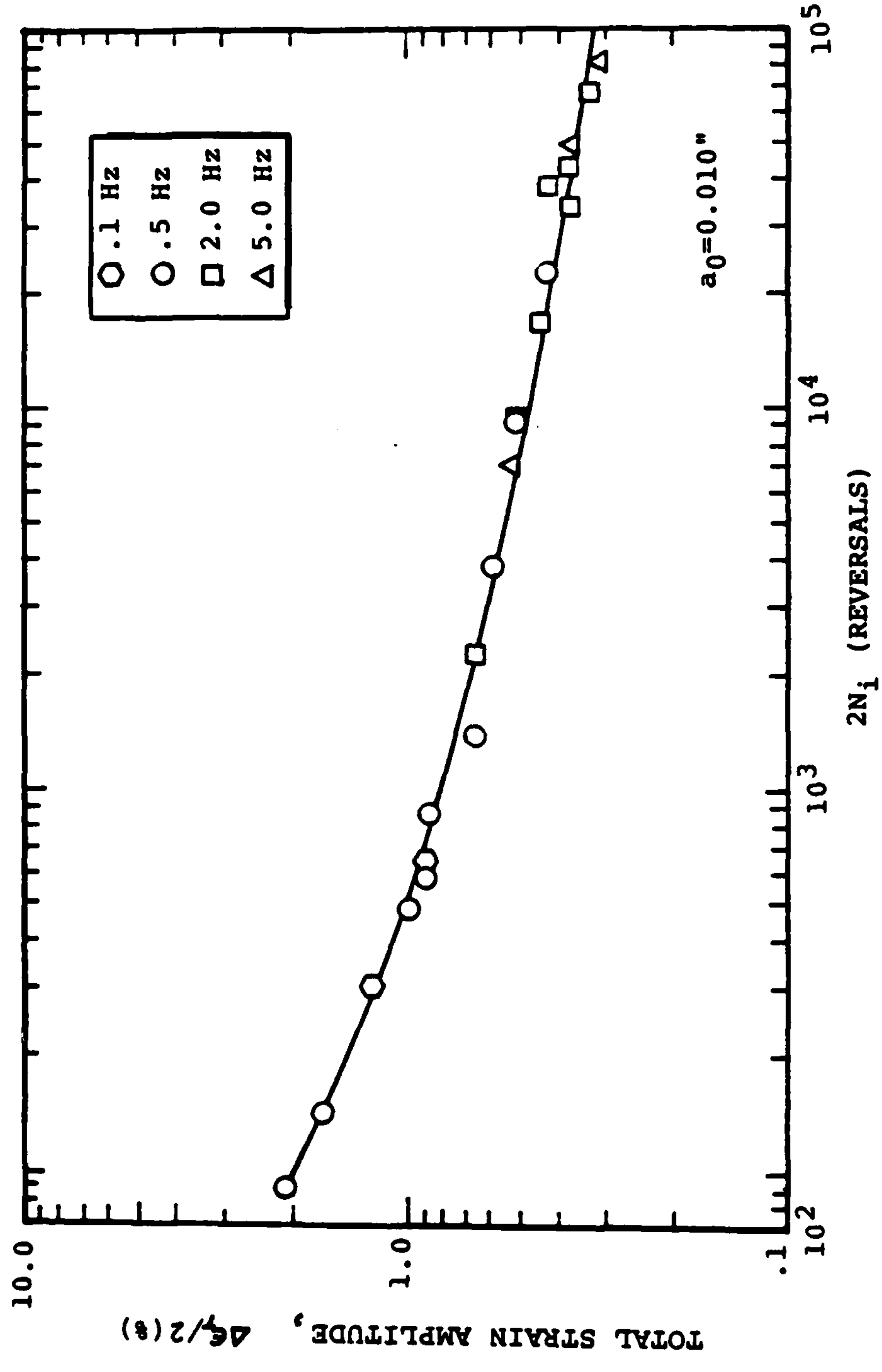

Fig. A10 Total Strain Amplitude Versus Reversals to Crack Initiation for 7075-T7651 Aluminum in a 3.5% NaCl Environment for Different Loading Frequencies

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APPENDIX B

STRAIN-CONTROLLED TEST RESULTS FOR BETA-ANNEALED TI-6AL-4V ALLOY

B.1 INTRODUCTION

Raw test results for Tasks 4 and 5 are presented in this Appendix. These results are evaluated and discussed in Volume III [1].

B.2 TASK 4 TEST RESULTS

Typical stress-strain hysteresis plots are shown in Figure B1. Monotonic and cyclic stress-strain properties for this material and basic material properties are given in Volume I [3].

Both the maximum tensile and compressive stresses decreased with cycling with the largest decrease during the first few cycles (Fig. B1). The decrease in the maximum tensile and compressive stresses with cycling was accompanied by an increase in the width of the hysteresis stress-strain plots (increase in plastic strain increment) and also the area enclosed by the hystersis loop (increase in plastic work).

The strain-controlled specimens (Fig. 1) for this material were calibrated using the same procedure developed for the 7075-T7651 aluminum alloy. Extensometer voltage output (axial

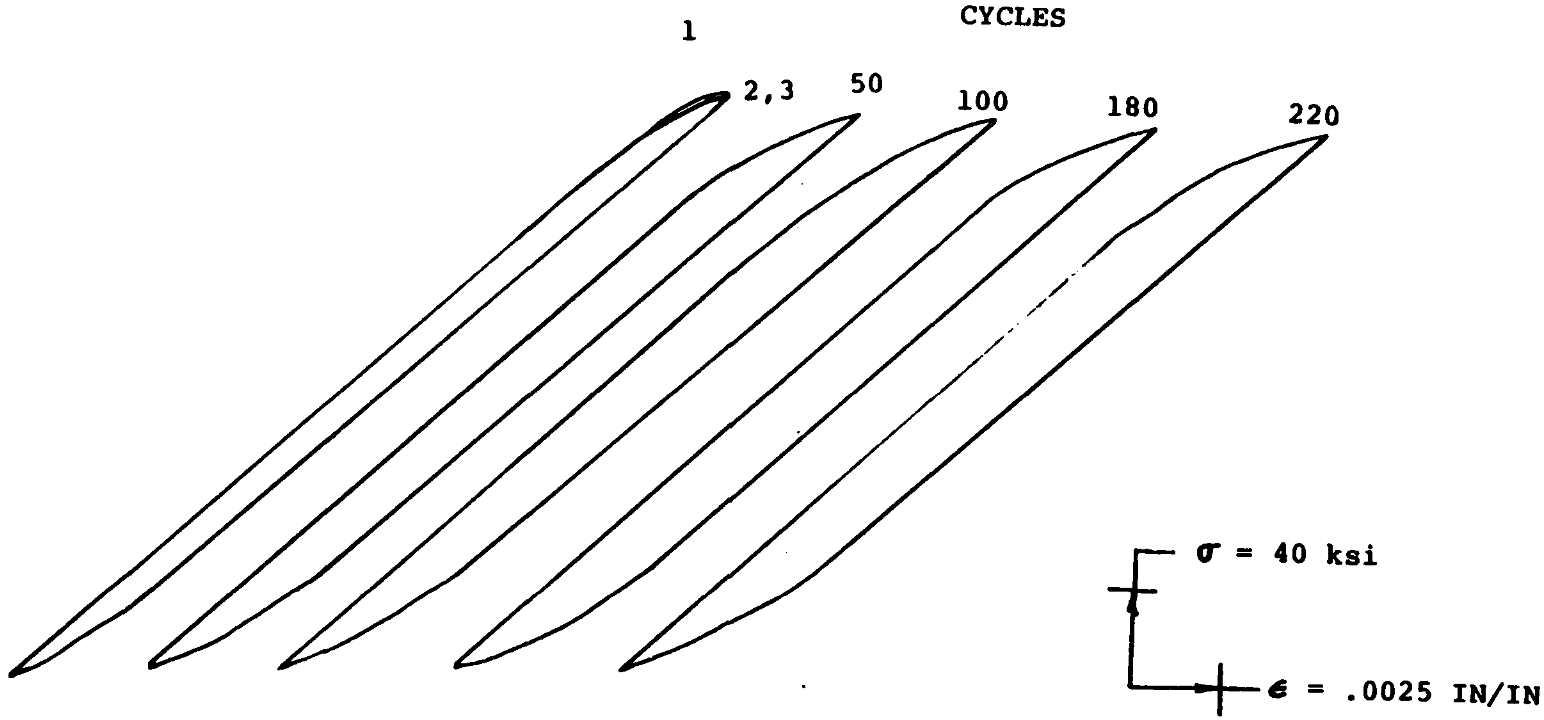

Fig. B1 Stress-Strain Hysteresis Loops During Fatigue Cycling for Beta-Annealed Ti-6Al-4V ($\Delta\varepsilon/2$ = 1.06%)

deformation) was measured as a function of axial strain in the reduced section of the specimen. These measurements were made by correlating extensometer voltage readings to strain gage readings for strain gages mounted axially in the minimum area sectin of the test specimen. A calibration curve based on these measurements is shown in Figure B2. This calibration curve was used to select extensometer voltages to obtain a specified strain value for the Task 5 experiments.

B.3 TASK 5 TEST RESULTS

Strain-controlled results for Task 5 are presented in Table B1 for lab air, dry air and 3.5% NaCl solution environments. The $2N_i$ reversals are for a crack depth of 0.010 inch. N_i was defined as the number of cycles in which a 2% decrease was observed in the maximum tensile stress compared to the maximum compressive stress.

The total strain amplitude versus $2N_i$ reversals to crack initiation (a_0 = 0.010 inch) is plotted in Figure B3 for lab air, dry air and 3.5% NaCl environments.

The effect of test frequency on crack initiation in both dry air and 3.5% NaCl environment were examined. Results are plotted in Fig. B4.

The change in the plastic strain amplitude versus $2N_i$ reversals to initiate a crack depth of 0.010 inch was

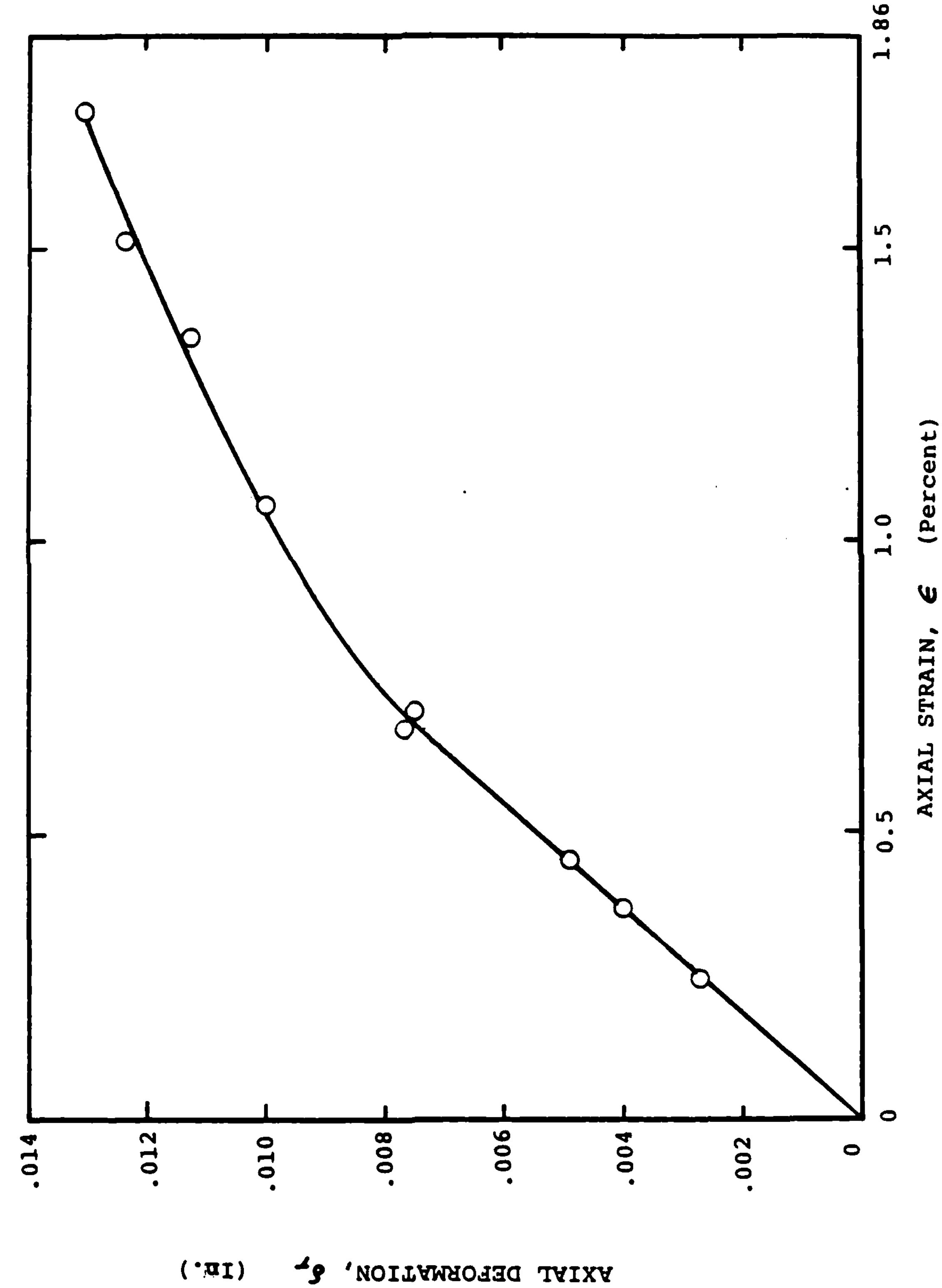

Fig. B2 Axial Deformation Versus Axial Strain for Strain-Controlled Specimen (Beta-Annealed Ti-6Al-4V)

Table B1 Strain-Controlled Test Results for Beta-Annealed Ti-6Al-4V Alloy in Both Dry Air and in 3.5% NaCl Solution Environments

Specimen No.	Total Strain Amp. (%)	Freq. (Hz)	$2N_i$ * (Reversals)	Environmental Condition
76CS	.44	5	197,400	Dry Air
77CS	.47	5	>500,000	3.5% NaCl
73CS	.52	2	31,840	3.5% NaCl
78CS	.52	5	>200,000	3.5% NaCl
79CS	.52	5	58,000	Dry Air
66CS	.52	2	32,440	Dry Air
82CS	.62	.5	14,000	Dry Air
85CS	.62	2	16,320	Dry Air
83CS	.62	.5	11,530	3.5% NaCl
84CS	.62	2	13,460	3.5% NaCl
70CS	.71	.5	3,800	Dry Air
68CS	.71	2	5,520	Dry Air
69CS	.71	.5	2,500	3.5% NaCl
67CS	.71	2	4,040	3.5% NaCl
72CS	.87	.5	1,100	Dry Air
71CS	.87	.5	800	3.5% NaCl
62CS	1.06	.5	340	Lab Air
75CS	1.06	.5	460	Dry Air
74CS	1.06	.5	430	3.5% NaCl
63CS	1.36	.1	210	Lab Air
81CS	1.36	.1	210	3.5% NaCl
64CS	1.50	.05	140	Dry Air
80CS	1.50	.05	110	3.5% NaCl
65CS	1.74	.1	96	Dry Air
89CS	.62	.3	13,140	Dry Air
86CS	.62	.5	10,840	Dry Air
87CS	.62	.5	7,800	Dry Air
88CS	.62	2.0	13,000	Dry Air
90CS	.62	5.0	19,480	Dry Air

* For crack depth = 0.010"

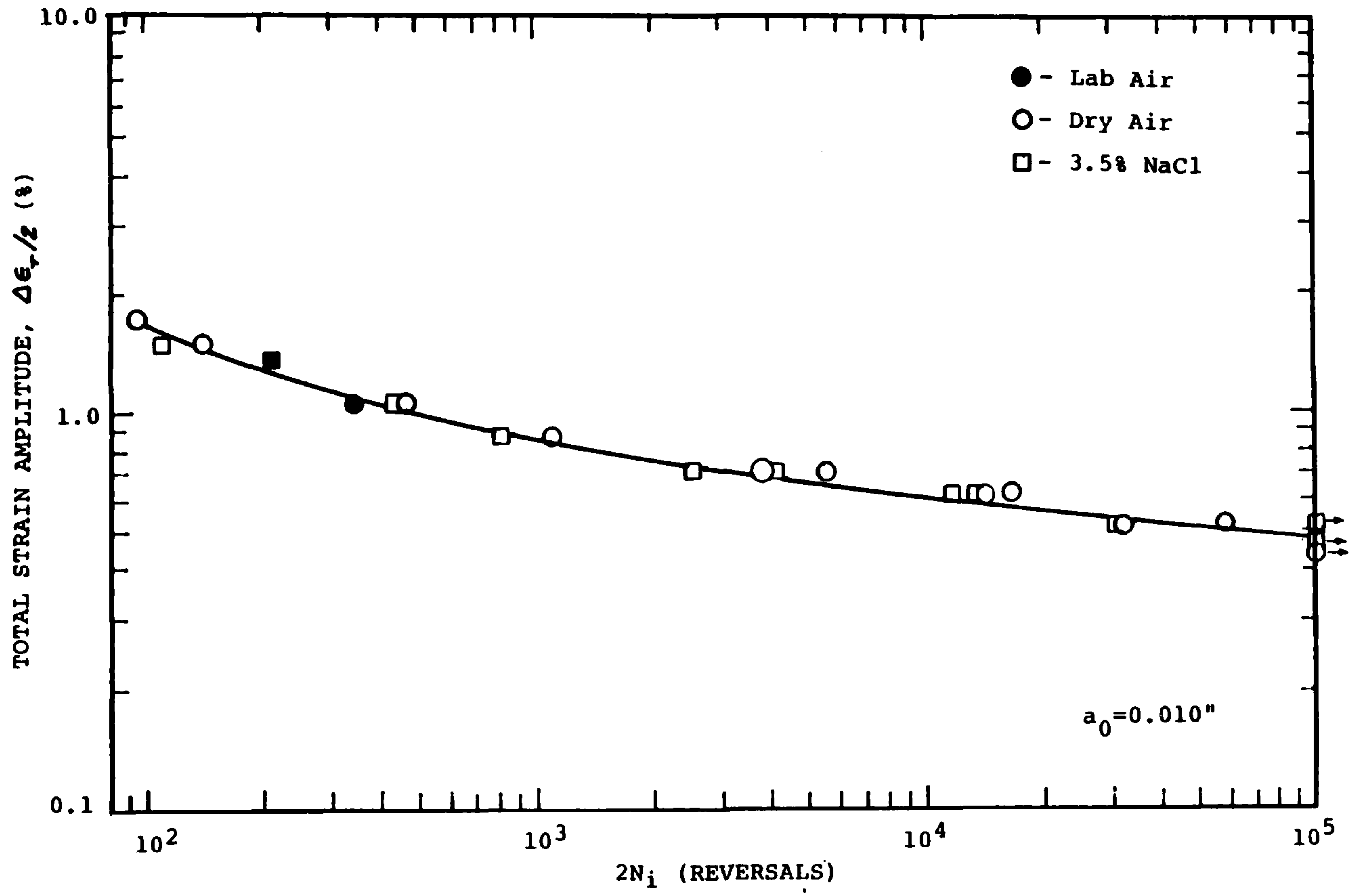

Fig. B3 Total Strain Amplitude Versus $2N_i$ Reversals to Initiation for Beta-Annealed Ti-6Al-4V in Both Dry Air and 3.5% NaCl Environments

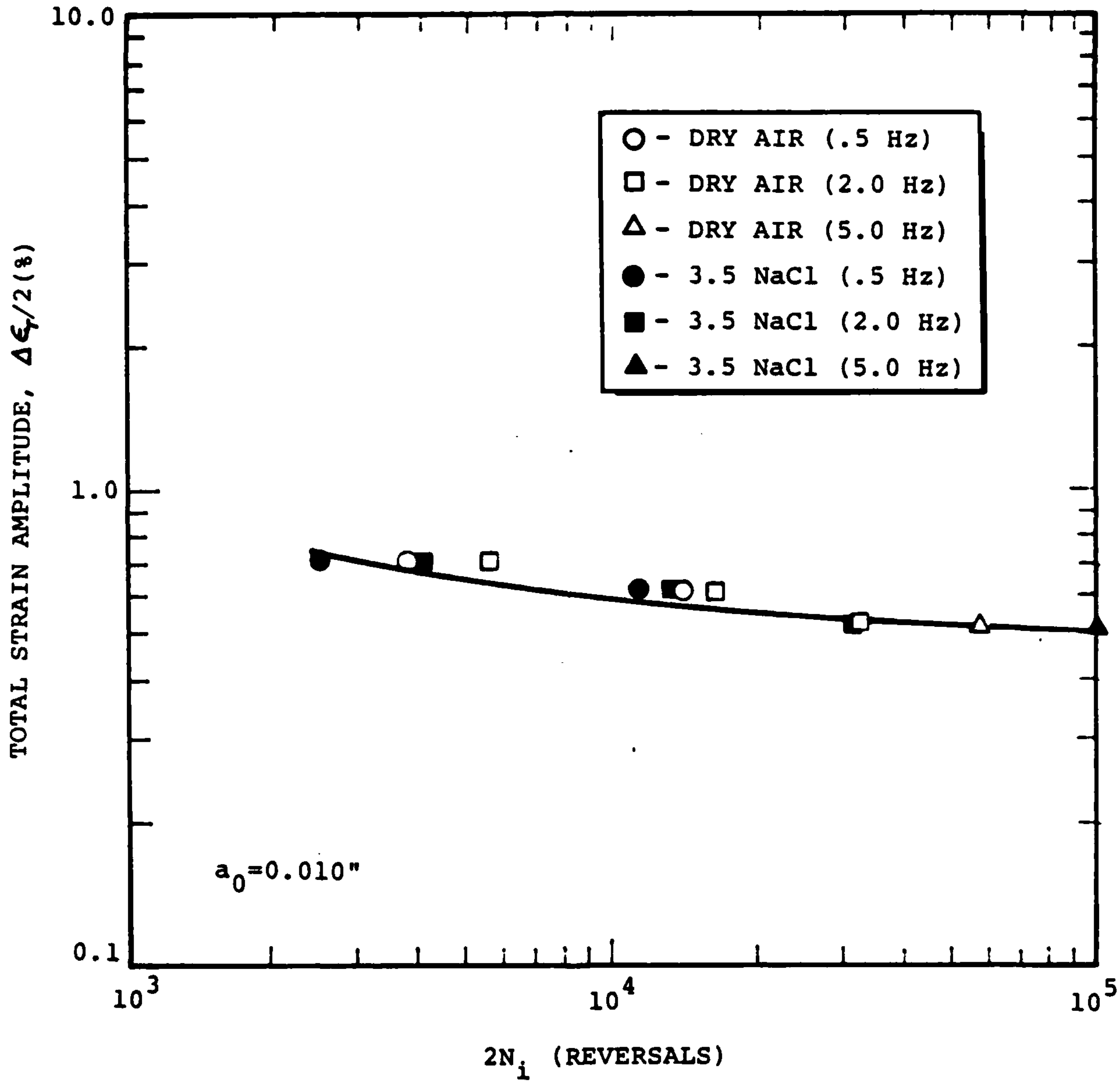

Fig. B4 Total Strain Amplitude Versus $2N_i$ Reversals to Crack Initiation for Different Loading Frequencies for Beta-Annealed Ti-6Al-4V in Both Dry Air and 3.5% NaCl Environments

investigated. Results are plotted in Figs. B5 and B6.

A plot of the plastic work per unit cycle versus $2N_i$ reversals to initiation (a_0 = 0.010 inch) for this alloy is shown in Figure B7. The area of the hysteresis stress-strain curve was measured from the loop in which the plastic strain amplitude was maximum.

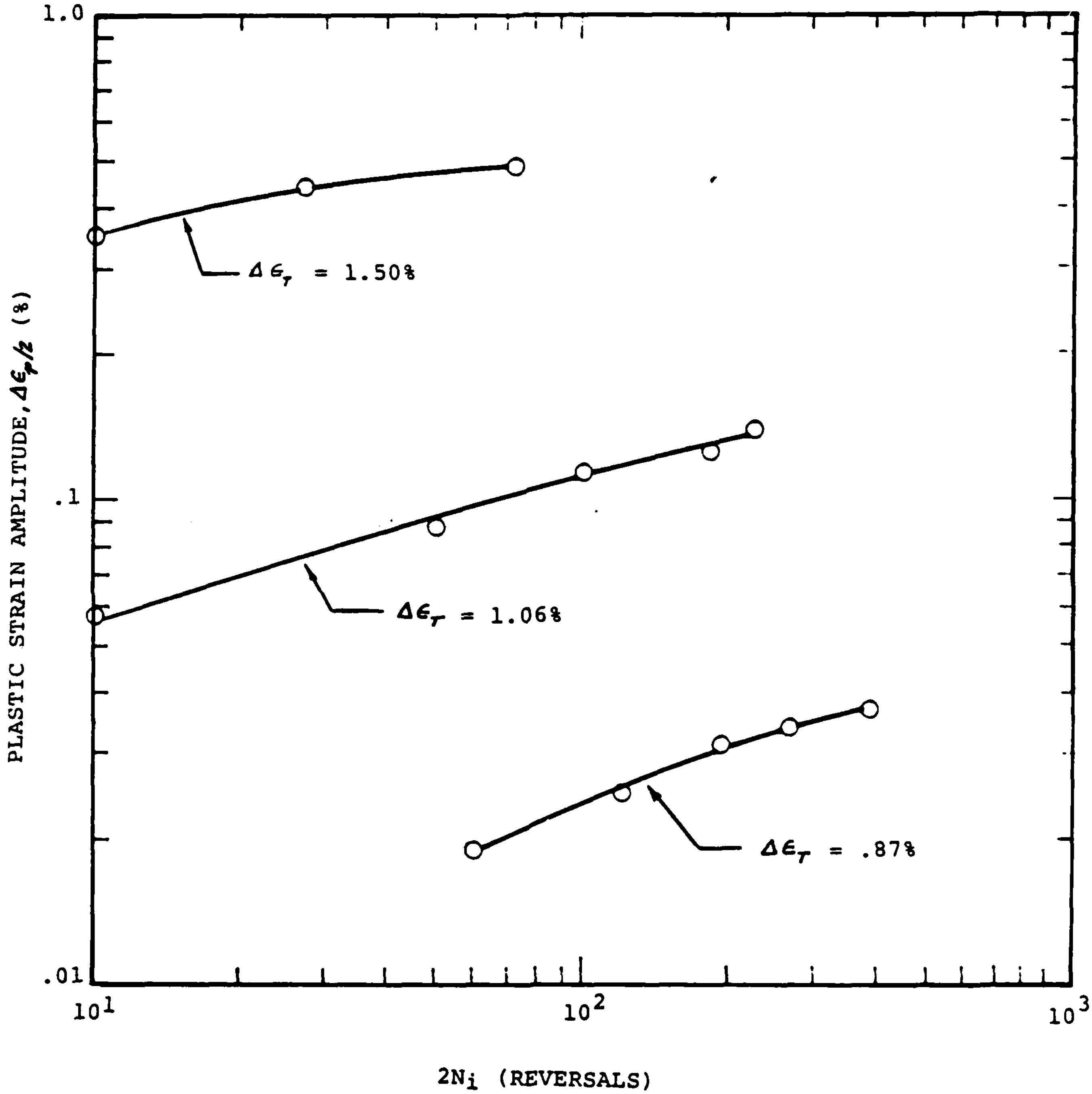

Fig. B5 Change in Plastic Strain Amplitude with Cycling for Beta-Annealed Ti-6Al-4V

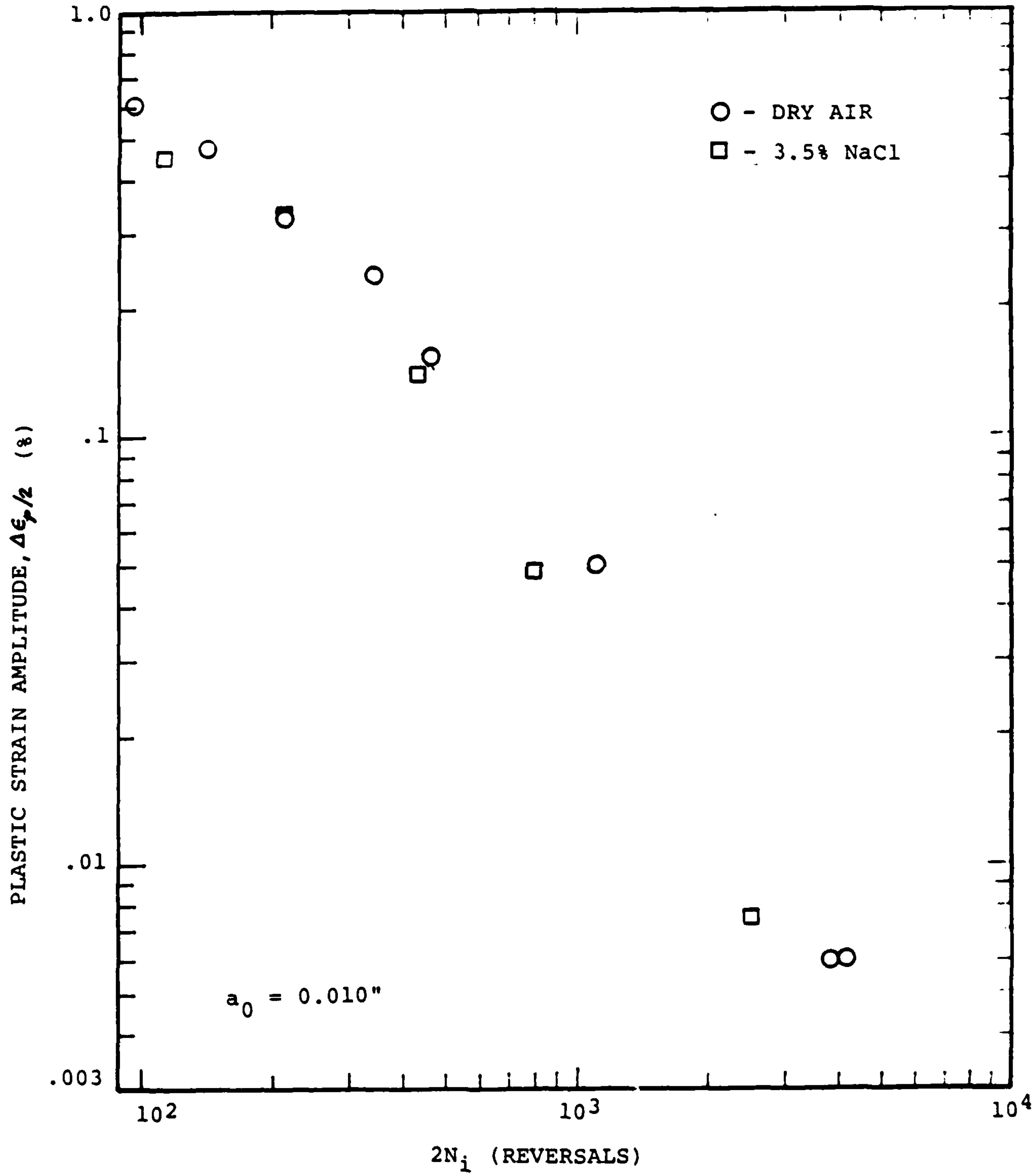

Fig. B6 Plastic Strain Amplitude Versus $2N_i$ Reversals to Crack Initiation for Beta-Annealed Ti-6Al-4V in Both Dry Air and 3.5% NaCl Environment

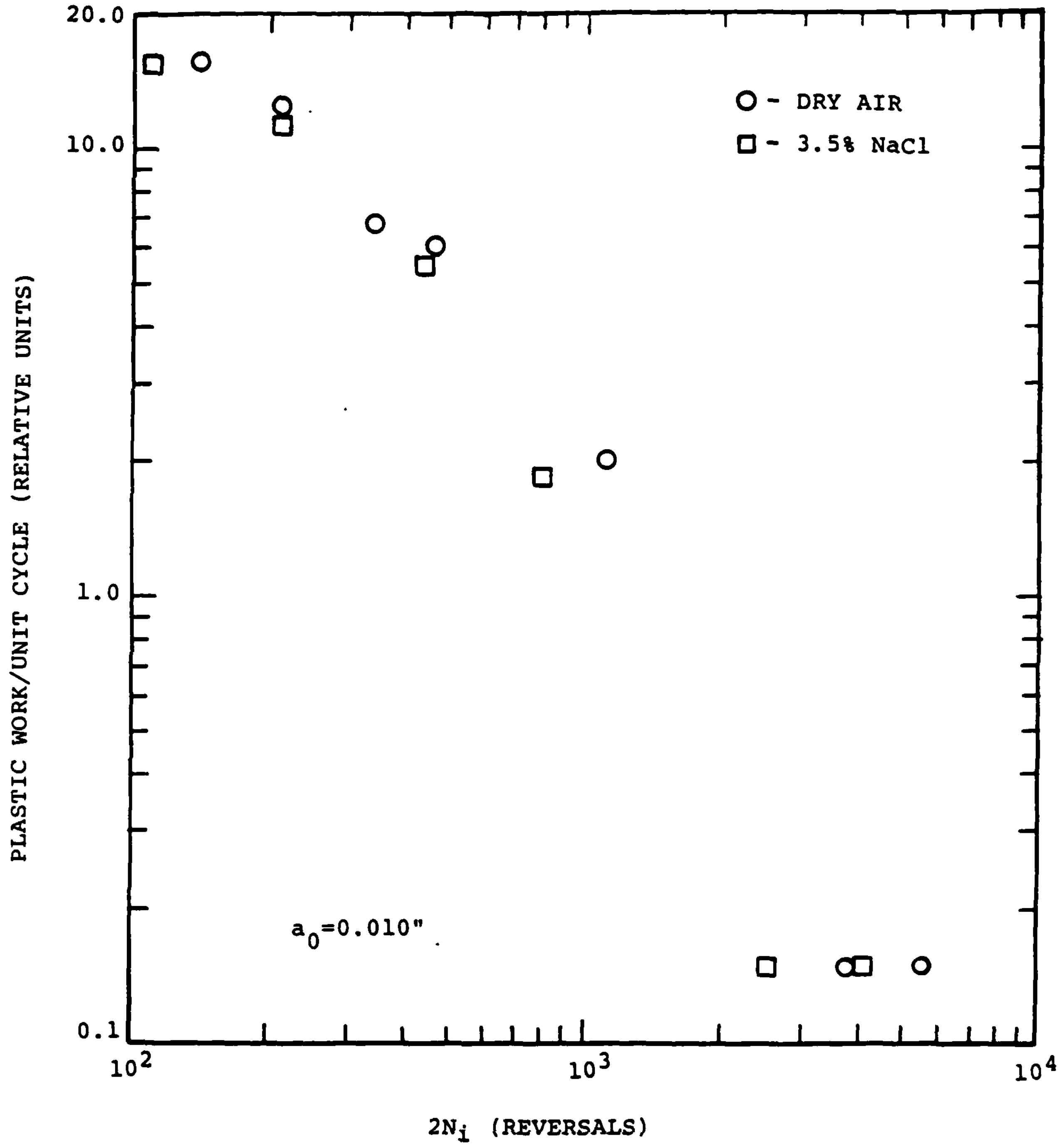

Fig. B7 Plastic Work Per Unit Cycle Versus $2N_i$ Reversals to Crack Initiation for Beta-Annealed Ti-6Al-4V in Both Dry Air and 3.5% NaCl Environments

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APPENDIX C

CONSTANT AMPLITUDE TEST RESULTS FOR DOG-BONE SPECIMENS (7075-T7651 ALUMINUM ALLOY

C.1 TASK 5 TEST RESULTS

Constant amplitude test results for preconditioned dog-bone specimens (open hole; Fig. 3) are presented in Table C1 for both dry air and 3.5% NaCl environments. These stress-controlled tests were conducted under Task 5 (Ref. Table 6) for selected stress ranges ($\Delta\sigma$). The number of cycles to initiate a crack size of 0.010 inch , N_i, and the number of cycles to failure, N_f, are shown in Table C1.

C.2 TASK 6 TEST RESULTS

Twelve stress - controlled tests were performed under Task 6 (Ref. Table 6) for two different percentages of bolt load transfer (i.e., 20% and 40%). Tests were performed in dry air and in a 3.5% NaCl solution environment. Results are presented in Table C2.

Table. C1 Constant Amplitude Stress-Controlled Test Results for Preconditioned Dog-Bone Specimens in Both Dry Air and 3.5% NaCl Environments (7075-T7651 Aluminum; R=0.05; Freq. - 6HZ; Open Hole)

SPECIMEN NO.	$\Delta\sigma$ (ksi)	N_f (cycles)	N_i (cycles)	ENVIRONMENT
200	16.5	92,827	70,000	Dry Air
204	15.0	85,720	52,000	Dry Air
202	14.0	99,389	70,000	Dry Air
199	14.0	38,202	25,000	3.5% NaCl
203	13.0	44,409	26,000	3.5% NaCl
205	12.0	167,539	95,000	3.5% NaCl
206	12.0	80,887	40,000	3.5% NaCl

Table C2 Constant Amplitude Stress-Controlled Test Results for Dog-Bone Specimens Tested for 20% LT and 40% LT in Both Dry Air and 3.5% NaCl Environments (7075-T7651 Aluminum)

ENVIRONMENT	SPECIMEN NUMBER	DATA SET NO.	$\Delta\sigma$ -(KSI)	PERCENT LOAD TRANSFER	NUMBER OF CYCLES TO INITIATION (a_o=0.010") N_i	NUMBER OF CYCLES TO FAILURE N_f
Dry Air	401	63	23	20	17,000	22,623
	400 402 403	64	17	" " "	49,000 48,000 35,000	61,958 58,715 40,000
	407 408	66		40 "	41,000 25,000	53,059 32,881
3.5% NaCl	404 405 406	65	17	20 " "	41,000 41,000 20,000	44,766 44,951 22,000
	410 412 413	67		40 " "	12,000 18,000 13,000	14,515 21,888 15,100

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APPENDIX D

SPECTRUM FATIGUE TEST RESULTS AND FRACTOGRAPHIC DATA FOR TASK 4 (7075-T7651 ALUMINUM ALLOY)

Spectrum fatigue test results for the dog-bone specimens (Fig. 3) tested under Task 4 are summarized in Table D1. Fractographic data sheets are also presented in this appendix.

The maximum positve load in spectrum "A" (F-16 400 hour block spectrum), 100% load level, was scaled to a test load that would produce the desired gross stress on the specimen cross section. All other loads, positive and negative, were "scaled" to the 100% load level.

Fatigue loading frequencies for spectrum "A" were selected such that the spectrum loads corresponding to 8000 equivalent flight hours could be applied to the respective test specimen in a selected number of days (24 hours a day continuous testing). Three loading frequencies were considered in task 4: (1) F = fast (8000 flight hours/2 days), (2) S = slow (8000 flight hours/16 days) and (3) M = medium (8000 flight hours/8 days).

Table D1 Summary of Dog-Bone Specimen Spectrum Fatigue Test Results for Task 4 (7075-T7651 Aluminum; F-16 400 Hour Spectrum)

SPECIMEN NO.	TEST I.D. (b)	DATA SET NO.	TEST DATE	SPECIMEN DETAILS				FATIGUE CRACK ORIGIN (f)	TTCI (FLT. HRS.) (g)	TTF (FLT. HRS.) (h)	TTF-TTCI (FLT. HRS.) (i)	TTCI/TTF
				WIDTH (IN.)	THICK (IN.)	HOLE DIA (IN.)	GROSS AREA (IN^2)					
41	A-34/S/W	43	3-3-83	1.9980	.3000	.2502	.5994	B	4657	6640	1983	.70
42	A-34/S/D	41	3-22-83	1.9985	.2990	.4404	.5976		4207	8408	4201	.50
43	A-32/F/W	45	3-24-83	2.00	.3060	.4415	.6120		5147(a)	7606	2459	.68
47	A-30/F/D	47	6-6-83	2.0100	.3010	.4452	.6050		4777	12432	7655	.38
48(a)	A-30/F/D	47	6-10-83	2.0100	.3010	.4422	.6050		(e)	13680	-	-
49	A-32/S/D	44	5-12-83	2.0115	.3010	.4495	.6055		5441	9606	4165	.57
50	A-32/S/D	44	5-16-83	2.0090	.3010	.4426	.6047		2200	9635	7435	.23
51	A-32/S/D	44	5-19-83	2.0100	.3010	.4426	.6050		1000(c)	8835	7835	.11
52(a)	A-30/S/D	48	5-31-83	2.0115	.3020	.4452	.6075		6143	12035	5892	.51
53	A-34/F/W	42	5-6-83	2.0140	.3000	.4450	.6042		433	3235	2802	.13
54	A-30/F/W	49	6-7-83	2.0135	.3015	.4455	.6071		(e)	7606	-	-
55	A-30/F/W	49	6-8-83	2.0145	.3020	.4504	.6084		3067	6678	3611	.46
56	A-30/F/W	49	6-6-83	2.0110	.3005	.4500	.6043	C	(e)	6407	-	-
57	A-34/S/W	43	5-6-83	2.0120	.3000	.4460	.6036	B	133(d)	2348	2215	.06
58	A-34/S/W	43	5-6-83	2.0115	.3010	.4457	.6055		1200	3206	2006	.37
59	A-32/S/W	46	5-16-83	2.0110	.3010	.4475	.6053		3289	5235	1946	.63
60	A-32/S/W	46	5-11-83	2.0120	.3015	.4465	.6066		4037	6348	2311	.64
61	A-32/M/W	46	5-11-83	2.0120	.3010	.4470	.6056		2451	4835	2384	.51
64	A-30/20/F/W	54	6-21-83	2.0080	.3045	.4392	.6114		(e)	6759	-	-
65	A-30/20/S/W	50	6-29-83	2.0090	.3040	.4408	.6107		(e)	5946	-	-
111(a)	A-28/F/W/B/PC	52	10-14-83	2.002	.301	.4395	.6026	S	(e)	(a)	-	-
121(a)	A-28/F/W/B	51	10-6-83	2.002	.303	.4415	.6066	S	(e)	39120	-	-
129	A-28/S/W/B/PC	53	12-13-83	2.0065	.3025	.4415	.6069	B	6916	11864	4948	.58
143(a)	A-28/F/W/B/PC	52	12-14-83	2.0090	.3030	.4420	.6067	B	6750(d)	11600	4850	.58
144	A-28/S/W/B/PC	53	1-9-84	2.0095	.3030	.4440	.6088	B	10500	16800	6300	.62

Notes for Table D1

(a) Testing anomaly
(b) Ref. Table 8 for description code
(c) Linear extrapolation from two smallest consecutive crack sizes from fractographic data sheet
(d) Extrapolation based on power law (Eqs. 1 and 3)
(e) Fractography not read for this specimen for various reasons (e.g., testing anomaly, not 28 ksi baseline stress surface crack away from hole).
(f) Fatigue crack origins: B = bore of hole, C = corner of hole and S = surface crack away from hole.
(g) Time to initiate crack depth of 0.010" in fastener hole (determined from fractographic results).
(h) Time-to-failure
(i) Time spent in crack growth

FATIGUE TEST DATA

SPECIMEN NUMBER: 41 (Open)

SPECTRUM: 400hr F16 Fighter (765747 ld pts)
'A'

TEST DATE: 3-3-83 //

W 1.9980" TH .3000" HOLE DIAM .2502" A .5994 in²

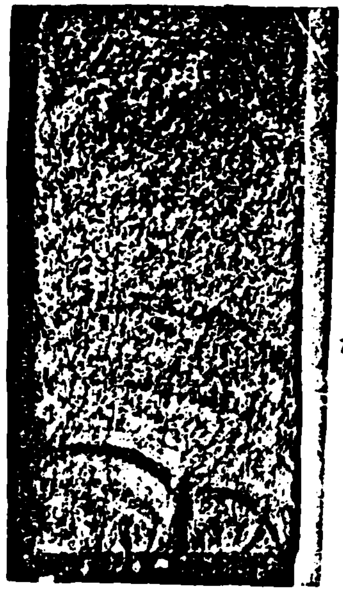
MAX STRESS 34 ksi FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 639230 ld pts % LIFE = 83

TTCI 4657 FLIGHT HOURS Larger Flaw = .550"

2X



* Smaller Flaw

5X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
F	16.[illegible]	[illegible]	.5245 *
	16	6400	.2175
	15	6000	.0735
	14	5600	.0305
	13	5200	.0205
	12	4800	.0125
TTCI →	11	4400	.0055
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

* data is for smaller flaw

FATIGUE TEST DATA

SPECIMEN NUMBER: 42 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 3-22-83 //

W 1.9985" TH .2990" HOLE DIAM .4404" A .5976 in²

MAX STRESS 34 Ksi FREQ. 1 LIFE = 16 hrs. (Slow)

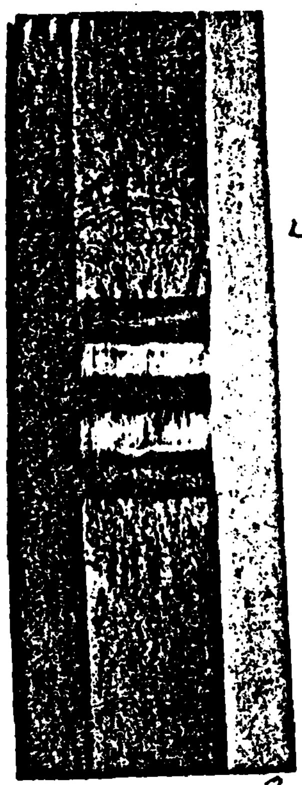
ENVIR. CONDS. Dry Air PREPS. —

CYCLES TO FAILURE 804672 ldpts % LIFE = 105.1

TTCI 4207 FLIGHT HOURS

Smaller Flaw = .180"

Larger Flaw = .268"



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
F	21.02	8408	.268
	21	8400	.195
	20	8000	.139
	19	7600	.102
	18	7200	.078
	17	6800	.0625
	16	6400	.049
	15	6000	.039
	14	5600	.022
	13	5200	.019
	12	4800	.016
TTCI →	11	4400	.012
	10	4000	.008
	9	3600	.0045
	8	3200	.0025
	7	2800	.0015
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 43 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 3-24-83 //

W 2.00" TH .3060" HOLE DIAM .4415" A .6120 in^2

MAX STRESS 32 KSI FREQ. 1 LIFE = (Fast) 2days (16hrs)

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 728069 ld pts % LIFE = 95

TTCI 5147 FLIGHT HOURS

Smaller Flaw = .380"

Larger Flaw = .401"

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
19016	7606.4	.4010
18	7200	.1695
17	6800	.1270
16	6400	.0790
15	6000	.0470
14	5600	.0240
13	5200	.0110
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 47 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-06-83 //

W 2.0100 TH .3010 HOLE DIAM .4452" A .6050 in²

MAX STRESS 30 FREQ. 1 LIFE = 2days (Fast) F

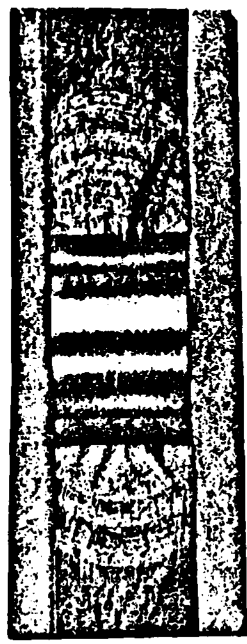
ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 1190278 % LIFE = 155

TTCI 4777 FLIGHT HOURS

Smaller Flaw = .190"

Larger Flaw = .3501"



3X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
31.08	12432	.3501
31	12400	.3368
30	12000	.2357
29	11600	.1778
28	11200	.1367
27	10800	.1065
26	10400	.0816
25	10000	.0678
24	9600	.0556
23	9200	.0463
22	8800	.0387
21	8400	.0332
20	8000	.0290
19	7600	.0239
18	7200	.0205
17	6800	.0172
16	6400	.0152
15	6000	.0138
14	5600	.0124
13	5200	.0119
12	4800	.0101
11	4400	.0084
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 48 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-10-83 //

W 2.010" TH .3010" HOLE DIAM .4422" A .6050in²

MAX STRESS 30ksi* FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. Dry PREPS. none

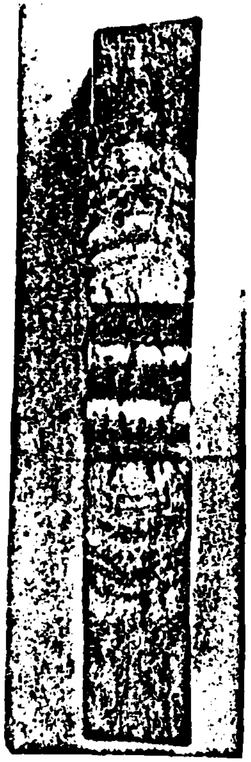
CYCLES TO FAILURE 1309458 ld pts % LIFE = 171

TTCI ______ FLIGHT HOURS

Smaller Flaw =

Larger Flaw =

L



S

2X

* low load for first half life

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	NO FRACTOGRAPHIC
36	14400	
35	14000	READINGS
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 49 (Open Hole)

SPECTRUM: 400 hr (A)

TEST DATE: 5/12/83 //

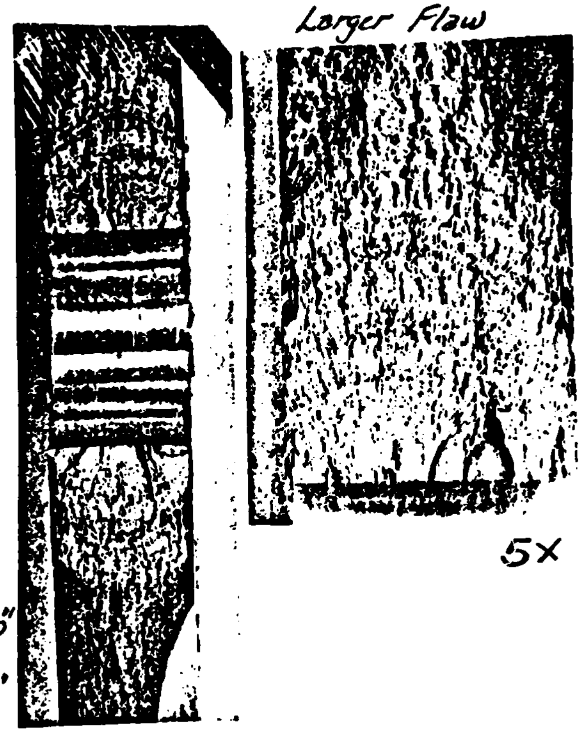
W 2.0115" TH .3010" HOLE DIAM .4495" A .6055 in²

MAX STRESS 32 KSI FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. Dry Air PREPS. none

CYCLES TO FAILURE 919507 ld pts. % LIFE = 120

TTCI 5441 FLIGHT HOURS



Smaller Flaw = .280"

Larger Flaw = .324"

(Larger Flaw)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
F 24.016	9606.4	.3240
24	9600	.2305
23	9200	.1520
22	8800	.1095
21	8400	.0775
20	8000	.0550
19	7600	.0460
18	7200	.0350
17	6800	.0275
16	6400	.0220
15	6000	.0165
14	5600	.0115
TTCI → 13	5200	.0080
12	4800	.0040
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 50 (Open hole)

SPECTRUM: 400hr(A)

TEST DATE: 5-16-83 //

W 2.009" TH .3010" HOLE DIAM .4426" A .6047in²

MAX STRESS 32 ksi FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. Dry PREPS. none

CYCLES TO FAILURE 9222.57 ld pts % LIFE = 120

TTCI 2200 FLIGHT HOURS

Smaller Flaw = .331"

Larger Flaw = .348"

2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
F	24	9600	.348
	23	9200	.223
	22	8800	.171
	21	8400	.137
	20	8000	.109
	19	7600	.087
	18	7200	.073
LF	17	6800	.060
	16	6400	.045
	15	6000	.037
	14	5600	.034
	13	5200	.028
	12	4800	.025
	11	4400	.022
	10	4000	.019
SF	9	3600	.018
	8	3200	.016
	7	2800	.013
TTCI	6	2400	.011
	5	2000	.009
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 51 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 5-19-83 / /

W 2.0100" TH .3010" HOLE DIAM .4426" A .6050in²

MAX STRESS 32Ksi FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. Dry Air PREPS. —

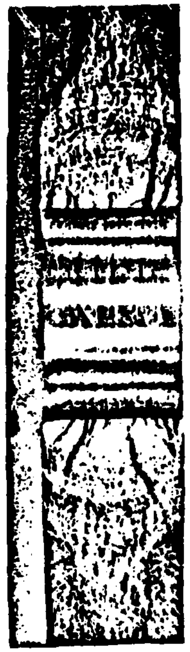
CYCLES TO FAILURE 845690 ld pts % LIFE = 110

TTCI 1000 FLIGHT HOURS

Larger Flaw = .352"

Smaller Flaw = .350"

S



L

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
F 22.088	8835.2	.3520
22	8800	.2795
21	8400	.1960
20	8000	.1515
19	7600	.1215
18	7200	.0960
17	6800	.0795
16	6400	.0650
15	6000	.0565
14	5600	.0470
13	5200	.0390
12	4800	.0350
11	4400	.0315
10	4000	.0280
9	3600	.0240
8	3200	.0220
7	2800	.0185
6	2400	.0170
5	2000	.0150
4	1600	—
TTCI 3	1200	—
2	800	—
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 52 (Open Hole)

SPECTRUM: 400 hr (A)

TEST DATE: 5-31-83 //

W 2.0115" TH .3020 HOLE DIAM .4452" A .6075 in²

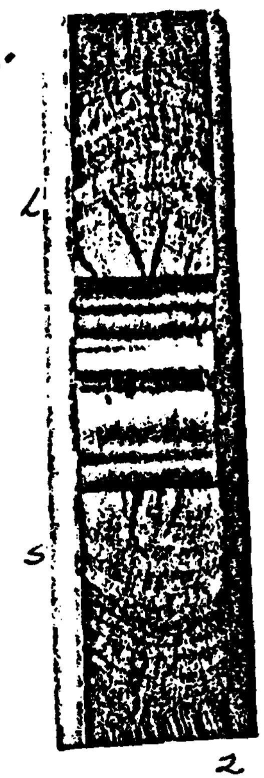
MAX STRESS 32 ksi for 7652 ld pts / 30 ksi for 1,144,339 ld pts FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. Dry PREPS. ——

CYCLES TO FAILURE 1151991 ld pts % LIFE = 150

TTCI 6143 FLIGHT HOURS

Smaller Flaw = .380"
Larger Flaw = .4034"



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
•30.09	12035	.4034
29	11600	.2664
28	11200	.1678
27	10800	.1278
26	10400	.0960
25	10000	.0766
24	9600	.0617
23	9200	.0518
22	8800	.0348
21	8400	.0320
20	8000	.0265
19	7600	.0207
18	7200	.0173
17	6800	.0140
16	6400	.0115
TTCI → 15	6000	.0092
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 53 (Open Hole)

SPECTRUM: 400 hr (A

TEST DATE: 5-6-83 //

W 2.0140" TH .3000" HOLE DIAM .4450" A .6042 in²

MAX STRESS 34 Ksi FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 309658 ldpts % LIFE = 40.4

TTCI 433 FLIGHT HOURS

Smaller Flaw = .320"

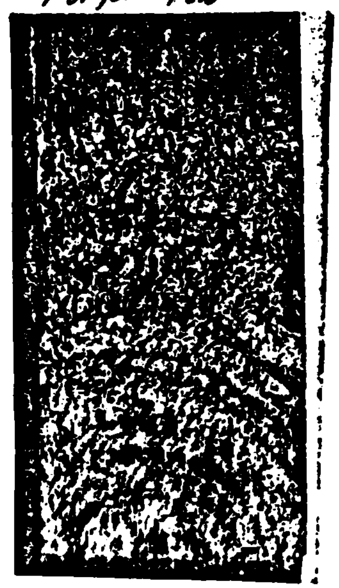
Larger Flaw = .492"

L

S

2.5X

Larger Flaw



5X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
F	8.8	3235.2	.492
	8	3200	.388
	7	2800	.284
	6	2400	.211
	5	2000	.175
	4	1600	.079
	3	1200	.034
	2	800	.021
TTCI →	1	400	.009

FATIGUE TEST DATA

SPECIMEN NUMBER: 54 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-7-83 //

W 2.0135" TH .3015" HOLE DIAM .4455" A .6071in²

MAX STRESS 30ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. none

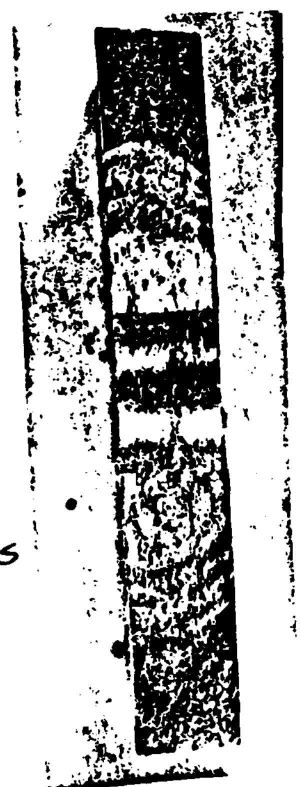
CYCLES TO FAILURE 728068 ld pts % LIFE = 95

TTCI ______ FLIGHT HOURS

Smaller Flaw =

Larger Flaw =

L



S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	NO FRACTOGRAPHIC
36	14400	READINGS
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 55 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-8-83 //

W 2.0145" TH .3020" HOLE DIAM .4504" A .6084 in²

MAX STRESS 30 FREQ. 1 LIFE = 2days (Fast)

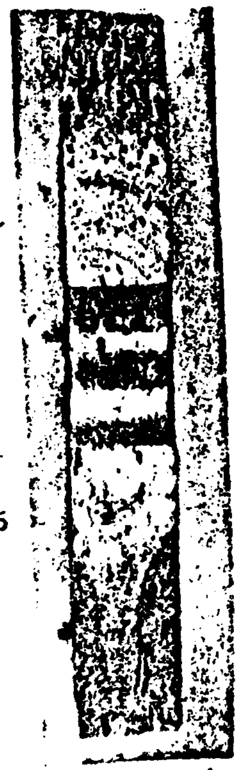
ENVIR. CONDS. 3.5% NaCl PREPS. ———

CYCLES TO FAILURE 639243 ld pts % LIFE = 83

TTCI 3067 FLIGHT HOURS

Smaller Flaw = .325"

Larger Flaw = .4352"



L

S

2X

TTCI →

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
F 16.70	6678 F	.4352
16	6400	.3332
15	6000	.1872
14	5600	.1102
13	5200	.0616
12	4800	.0410
11	4400	.0232
10	4000	.0144
9	3600	.0135
8	3200	.0108
7	2800	.0084
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 56 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-6-83 //

W 2.0110" TH .3005" HOLE DIAM .4500" A .6043 in²

MAX STRESS 30 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 613235 ld pts % LIFE = 80

TTCI ______ FLIGHT HOURS

Smaller Flaw =

Larger Flaw =

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	NO FRACTOGRAPHIC
36	14400	
35	14000	READINGS
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 57 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 5-6-83 //

W 2.0120" TH .3000" HOLE DIAM .4460' A .6036in²

MAX STRESS 34 KSI FREQ. 1 LIFE = 16days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 224834 ldpts. % LIFE = 29.4

TTCI 133 FLIGHT HOURS

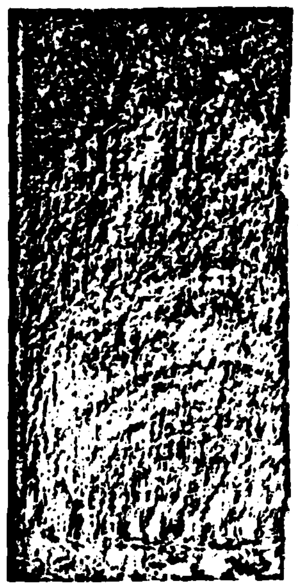
Smaller Flaw = .334

Larger Flaw = .446

L

5

2.8X



5X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	9	3600	
	8	3200	
	7	2800	
F	5.0T	2342	.3345
	5	2000	.1920
	4	1600	.1300
	3	1200	.0680
	2	800	.0320
	1	400	.0265

FATIGUE TEST DATA

SPECIMEN NUMBER: 58 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 5-6-83 //

W 2.0115" TH .3010" HOLE DIAM .4457" A .6055 in²

MAX STRESS 34 Ksi FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 306908 ld pts % LIFE = 40.1

TTCI 1200 FLIGHT HOURS

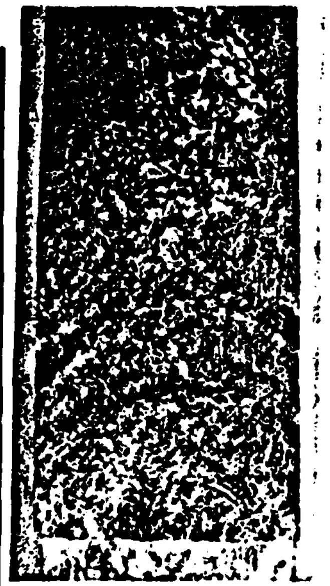
Smaller Flaw = .300"

Larger Flaw = .515"

L

S

2.66X



Larger Flaw 5X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
F 8.016	3206.4	.515
8	3200	.395
7	2800	.182
6	2400	.067
5	2000	.043
4	1600	.024
TTCI → 3	1200	.010
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 59 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 5/16/83 //

W 2.0110" TH .3010" HOLE DIAM .4475" A .6053 in²

MAX STRESS 32 ksi FREQ. 1 LIFE = 16 days (Slow)

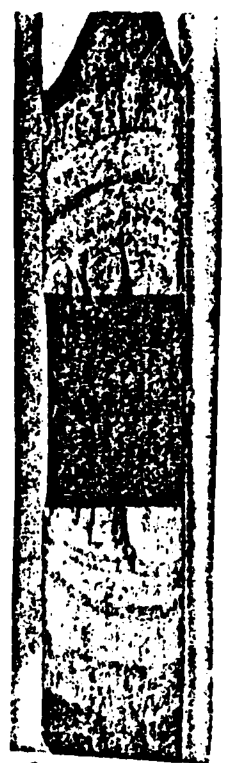
ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 501100 ld pts. % LIFE = 65

TTCI 3289 FLIGHT HOURS

Smaller Flaw = .432"

Larger Flaw = .455"



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
F 13.038	5235.2	.4550
13	5200	.2575
12	4800	.0810
11	4400	.0420
10	4000	.0220
TTCI → 9	3600	.0140
8	3200	.0090
7	2800	.0045
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 60 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 5-11-83 //

W 2.0120" TH .3015" HOLE DIAM .4465" A .6066 in²

MAX STRESS 32 ksi FREQ. 1 LIFE = 16 days (Slow)

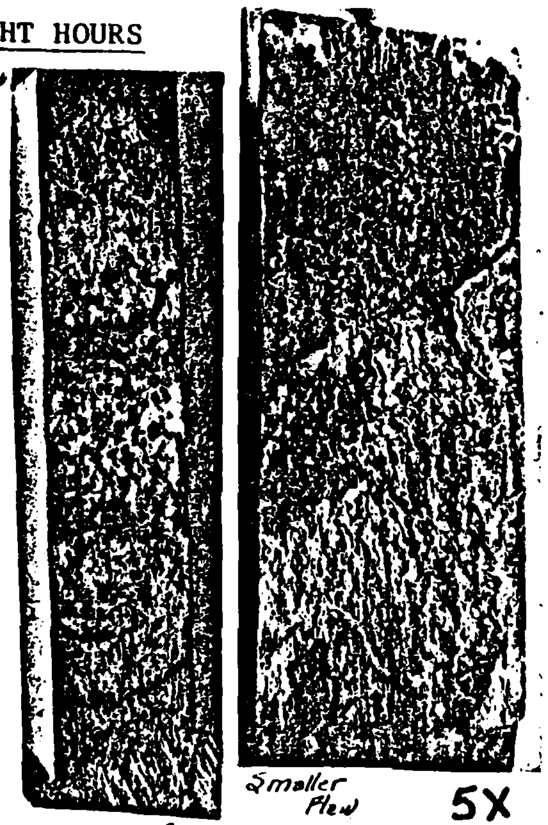
ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 607715 ld pts. % LIFE = 79.4

TTCI 4037 FLIGHT HOURS

Smaller Flaw = .428"

Larger Flaw = .531"



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
F	15.87	6348	.531
	15	6000	.201
	14	5600	.084
	13	5200	.052
	12	4800	.0315
TTU →	11	4400	.020
	10	4000	.009
	9	3600	.0035
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 61 (Open)

SPECTRUM: 400 hr. (A)

TEST DATE: 5-11-83 //

W 2.0120" TH .3010" HOLE DIAM .4470" A .6056 in²

MAX STRESS 32 ksi FREQ. 1 LIFE = 8 days

ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 462,824 ld pts % LIFE = 60.4

TTCI 2451 FLIGHT HOURS

Smaller Flaw = .320"

Larger Flaw = .527"

Larger Flaw

2.66X

5X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
F	12.038	4825.2	.527
	12	4800	.4805
	11	4400	.2455
	10	4000	.1120
	9	3600	.0320
	8	3200	.0240
TTCI →	7	2800	.0140
	6	2400	.0095
	5	2000	.0050
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 64 (20% Load Transfer)

SPECTRUM: 400 hr (A)

TEST DATE: 6-21-83 //

W 2.0080' TH .3045' HOLE DIAM .4392" A .6114 in²

MAX STRESS 30 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 646914 ld pts % LIFE = 84

TTCI ______ FLIGHT HOURS

Smaller Flaw =

Larger Flaw =

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	NO FRACTOGRAPHIC
36	14400	READINGS
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
F16.9	6759	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 65 (20% LOAD TRANSFER)

SPECTRUM: 400hr(A)

TEST DATE: 6-29-83 //

W 2.0090" TH .3040" HOLE DIAM .4408" A .6107in²

MAX STRESS 30 ksi FREQ 1 LIFE = 16 days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 569161 1d pts % LIFE = 74

TTCI ______ FLIGHT HOURS

Smaller Flaw =

Larger Flaw =

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	FRACTOGRAPHY NOT
36	14400	READ
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
14.87	5946	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 111 (Bolt-In)

SPECTRUM: F16-400hr(A)

TEST DATE: 10-14-83 //

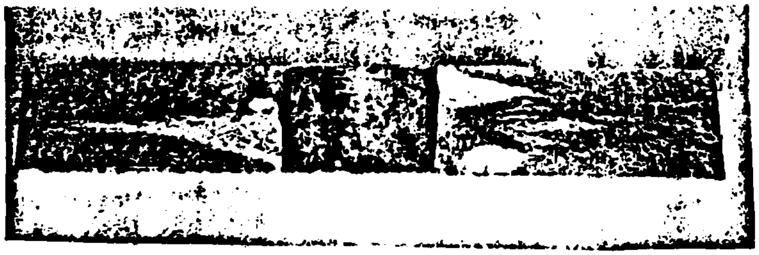
W 2.002" TH .301" HOLE DIAM .4395" A .6026 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. pre-cond.

CYCLES TO FAILURE 6891723 ld pts % LIFE*

TTCI ______ FLIGHT HOURS



2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	TASK 4
38	15200	
37	14800	
36	14400	
35	14000	NO FRACTOGRAPHIC
34	13600	READINGS
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

* Static Failure after 9 lives (P_{max} = 30,600 lbs)
Tight fitting bolt.

FATIGUE TEST DATA

SPECIMEN NUMBER: 121 (Bolt-In)*

SPECTRUM: F16-400hr

TEST DATE: 10-06-83 //

W 2.002" TH .303" HOLE DIAM .4415" A .6066in²

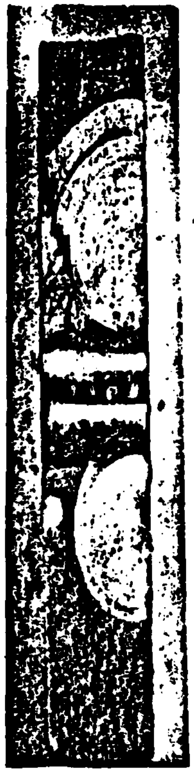
MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. NO

CYCLES TO FAILURE 3740699 ld pts % LIFE = 489

TTCI ______ FLIGHT HOURS

Smaller Flaw = 2c = .434"
Larger Flaw = 2c = .648"



2X

*Surface Flaw

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	NO FRACTOGRAPHIC READINGS
36	[illegible]	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 129 Bolt

SPECTRUM: 400hr F-16

TEST DATE: 12-13-83 //

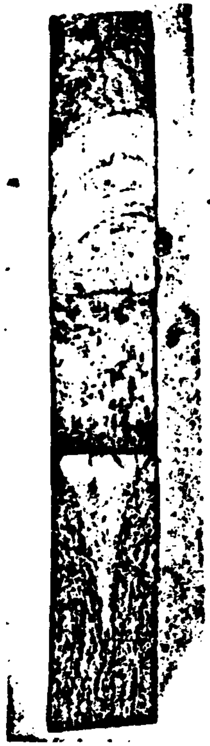
W 2.0065" TH .3025" HOLE DIAM .4415" A .6069 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow) FM=40

ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 1135746 ld pts % LIFE = 1483

TTCI 6916 FLIGHT HOURS



L

S

2X

Larger Flaw = .519" (B)

Smaller Flaw = .086" (B)

TTCI →

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
F 29.66	11864	.519
29	11600	.379
28	11200	.295
27	10800	.213
26	10400	.156
25	10000	.124
24	9600	.091
23	9200	.079
22	8800	.062
21	8400	.051
20	8000	.034
19	7600	.0185
18	7200	.0140
17	6800	.0080
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 143 (Bolt-In)

SPECTRUM: F16-400hr (A)*

TEST DATE: 12-14-83 //

W 2.009" TH .3030" HOLE DIAM .4420" A .6067 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days/Fast FH=250

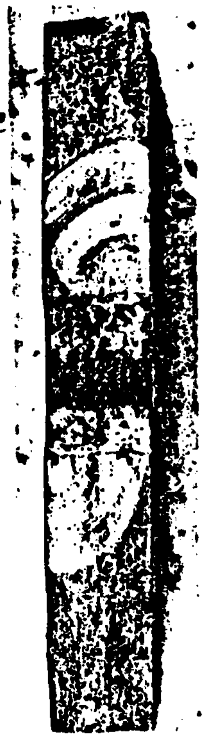
ENVIR. CONDS. 3.5% NaCl PREPS. p.c.

CYCLES TO FAILURE 1110948 ld pts % LIFE = 145

TTCI 6750 FLIGHT HOURS

Larger Flaw = .424" B

Smaller Flaw = .325" B



TTCI →

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600 F	.4240
28	11200	—
27	10800	.2245
26	10400	.1645
25	10000	.1380
24	9600	.1065
23	9200	.0765
22	8800	.0640
21	8400	.0520
20	8000	.0420
19	7600	.0340
18	7200	.0210
17	6800	.0105
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

*unexpected 82% load seen at 596193 ld pts.

FATIGUE TEST DATA

SPECIMEN NUMBER: 144 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 1-09-84 //

W 2.0095" TH .3030" HOLE DIAM .4440" A .6088 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow) FH=40

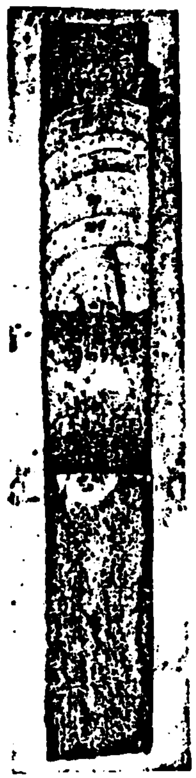
ENVIR. CONDS. 3.5% NaCl PREPS. p.c.

CYCLES TO FAILURE 1608695 ldpts % LIFE = 210

TTCI 10,500 FLIGHT HOURS

Larger Flaw = .583" (B)

Smaller Flaw = .075" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.301
39	15600	.205
38	15200	.138
37	14800	.093
36	14400	.066
35	14000	.053
34	13600	.042
33	13200	.036
32	12800	.029
31	12400	.025
30	12000	.021
29	11600	.018
28	11200	.015
27	10800	.013
26 (TTCI)	10400	.009
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
F 42	16800	.583
41	16400	.435

APPENDIX E

SPECTRUM FATIGUE TEST RESULTS AND FRACTOGRAPHIC DATA FOR TASK 5 (7075-T7651 ALUMINUM ALLOY)

Spectrum fatigue test results for the dog-bone specimens (Fig. 3) tested under Task 5 are summarized in Table E1. Fractographic data sheets are also presented in this appendix.

The maximum positive load in each load spectra, including overloads, was considered to be the 100% load level. The maximum positive test load for each spectra was selected to produce the desired gross stress on the specimen cross section. All other loads positive and negative in each respective test spectra were "scaled" to the 100% load level. As a result, "overloads" in the F-18 300 hour spectrum were treated as 100% load levels rather than a percentage greater than the 100% load level.

Fatigue loading frequencies for all spectrum tests, including the F-18 300 hour spectrum, were based on the test rates set for the F-16 400 hour spectrum tests. Loading rates were selected to complete 8000 equivalent flight hours of the F-16 400 hour spectrum in a selected number of days (24 hours a day continuous testing). Three basic loading frequencies were considered: (1) F = fast (8000 flight hours/2 days), (2) S = slow (8000 flight hours/16 days) and (3) [illegible] = extra slow (8000 flight hours/90 days). Accordingly, test machine frequency multipliers (FM) were set for the three basic frequencies: Fast (FM = 250), slow (FM = 40) and extra slow (FM = 1). The frequency multipliers can only be translated into actual frequency measurements for constant amplitude loading.

Table E1 Summary of Dog-Bone Specimen Spectrum Fatigue Test Results for Task 5 (7075-T7651 Aluminum)

SPECIMEN NO.	TEST I.D. (a)	DATA SET NO.	TEST DATE	SPECIMEN DETAILS WIDTH (IN.)	THICK (IN.)	HOLE DIA (IN.)	GROSS AREA (IN^2)	FATIGUE CRACK ORIGIN (b)	TTCI (FLT. HRS.) (c)	TTF (FLT. HRS.) (d)	TTF-TTCI (FLT. HRS.) (e)	TTCI / TTF
45	A-28/F/D	1	5-31-83	2.0170	.3010	.4412	.6071	B	14000	22000	8000	.64
46	A-28/F/D	1	6-5-83	2.0100	.3005	.4434	.6040	B	6600	16035	9435	.41
62	A-28/F/W	3	6-22-83	2.0110	.3025	.4380	.6083	B	5872	12035	6163	.49
67	A-28/S/W	4	7-1-83	2.012	.3050	.4427	.6137	C	7531(f)	14835	7304	.51
71	A-28/S/W	4	7-13-83	2.005	.3040	.4455	.6095	C	1600	7606	6006	.21
72	A-28/S/D	2	7-21-83	1.9980	.2915	.4440	.5824	B	8471	16435	7964	.52
76	A-28/F/W	3	7-5-83	1.9990	.3045	.4395	.6087	B	8000	13999	5999	.57
77	A-28/F/W	3	8-1-83	2.0105	.3030	.4395	.6092	B	16400	21949	5549	.75
79	A-28/F/D	1	8-11-83	2.0065	.3045	.4435	.6110	B	10600	17558	6958	.60
81	A-28/S/W	4	8-17-83	2.0095	.3025	.4395	.6079	B	3434	6749	3315	.51
82	A-28/F/W	3	8-18-83	2.0120	.3020	.4395	.6076	C	6700	12035	5335	.56
83	A-28/S/D	2	8-22-83	2.0030	.3030	.4395	.6069	B	25200	33677	8477	.75
84	A-28/Lo/W	5	9-12-83	2.002	.3020	.4440	.6046	B	8063(f)	10228	2165	.79
85	A-28/Lo/W	5	9-20-83	2.0025	.2880	.4430	.5767	B	8160(f)	10430	2270	.78
86	A-28/Lo/W	5	9-20-83	2.0085	.3010	.4443	.6045	B	8178(f)	12406	4228	.66
87	A-28/S/D	2	10-6-83	2.0005	.3025	.4410	.6052	B	16800	24835	8035	.68
88	A-28/S/W	4	11-8-83	2.000	.3010	.440	.6020	B	12554(f)	15074	2520	.83
89	A-28/F/D	1	11-3-83	2.006	.3045	———(i)	.6108	B	21600	32806	11206	.66
90	A-28/S/W	4	11-3-83	2.013	.3040	———(i)	.6119	C	15226(f)	21635	6409	.70
91	A-28/S/W	4	11-3-83	2.006	.303	———(i)	.6078	B	9400	18276	8876	.51
92	A-28/S/D	2	12-5-83	2.009	.301	.4435	.6047	B	13249(f)	24279	11030	.54
101	A-28/20/F/W/PC	37	8-23-83	2.0065	.2990	.4380	.5999	B	3775	6007	2232	.63
102	A-28/F/W/PC	8	8-16-83	2.0065	.3010	.4370	.6039	C	1622	4835	3213	.34
103	A-28/F/D/PC	6	8-17-83	2.0090	.3025	.4395	.6077	C	10800	27235	16435	.40
104(h)	A-28/20/F/W/PC	37	8-24-83	2.0045	.2990	.4380	.5993	B	2812	5550	2738	.51
105	A-28/F/D/PC	6	8-24-83	2.0125	.3040	.4395	.6118	B	6651	20007	13356	.33
106	A-28/F/D/PC	6	8-24-83	2.0025	.3030	.4395	.6067	B	2800	10806	8006	.26
107	A-28/F/W/PC	8	8-25-83	2.0045	.3035	.4395	.6083	B	1600	6806	5206	.24
108	A-28/F/W/PC	8	8-26-83	2.0045	.3030	.4395	.6074	B	1097	4192	3095	.26

Table E1 Summary of Dog-Bone Specimen Spectrum Fatigue Test Results for Task 5 (7075-T7651 Aluminum) (Continued)

SPECIMEN NO.	TEST I.D. (a)	DATA SET NO.	TEST DATE	SPECIMEN DETAILS WIDTH (IN.)	THICK (IN.)	HOLE DIA (IN.)	GROSS AREA (IN^2)	FATIGUE CRACK ORIGIN (b)	TTCI (FLT. HRS.) (c)	TTF (FLT. HRS.) (d)	TTF-TTCI (FLT. HRS.) (e)	TTCI/TTF
109	A-28/S/D/PC	7	8-26-83	2.0055	.3030	.4395	.6076	C	28000	43596	15596	.64
110	A-28/S/D/PC	7	8-30-83	2.012	.3045	.4395	.6126	B	18400	31325	12925	.59
112	A-28/F/W/B/PC	14	10-28-83	2.003	.303	.4415	.6069	B	3120	9635	6515	.32
113	A-28/S/W/PC	9	9-2-83	2.002	.3045	.4400	.6096	B	875	2806	1931	.31
114	A-28/F/W/B/PC	14	10-31-83	2.004	.3015	.4390	.6042	B	2323(f)	10000	7677	.23
115	A-28/S/W/PC	9	9-12-83	2.0110	.3035	.4395	.6103	B	4440	7245	2805	.61
116	A-28/F/W/B/PC	14	10-31-83	2.0095	.3015	.4395	.6059	C	4549	10835	6286	.42
117	A-28/S/D/PC	7	12-9-83	2.0090	.3010	----(i)	.6047	B	23600	32000	8400	.74
122	A-28/F/W/B	11	10-18-83	1.9983	.304	.4415	.6075	B	3200	16006	12806	.20
123	A-28/F/W/B	11	10-21-83	2.0090	.3040	.4410	.6107	B	13868	18902	5034	.73
124	A-28/F/W/B	11	10-25-83	2.0080	.3015	.4435	.6054	B	11600	16806	5206	.69
125	A-28/F/W/B	11	10-28-83	2.0030	.303	.4405	.6069	C	5777	10358	4581	.56
126	A-28/F/D/B	10	11-28-83	2.009	.304	.4435	.6099	B	23600	36035	12435	.65
127	A-28/F/D/B	10	11-18-83	2.00	.3005	.4415	.6010	B	14800	24748	9948	.60
128	A-28/F/D/B	10	11-29-83	2.0030	.3045	.4430	.6099	B	35600	42835	7235	.83
131	A-28/S/W/B	12	12-14-83	2.0035	.3045	.4420	.6100	C	8359(f)	14007	5648	.59
132	A-28/S/W/B	12	12-16-83	2.003	.3035	.4485	.6079	C	9300(g)	20435	11135	.46
140	A-28/F/D/B/PC	13	12-1-83	2.002	.3035	----(i)	.6076	B	3857(g)	17440	13583	.22
141	A-28/F/D/B/PC	13	12-5-83	2.0115	.3010	.4415	.6055	B	9200	22000	12800	.42
142	A-28/F/D/B/PC	13	12-7-83	2.0035	.3010	.4415	.6031	B	12400	24400	12000	.51
300	B-28/F/W	23	2-1-84	2.0240	.3030	.4460	.6133	B	13002(f)	16646	3644	.78
301	B-28/F/W	23	2-1-84	2.0030	.3038	.4470	.6085	B	9077	12152	3075	.75
302	B-28/F/W	23	2-2-84	2.001	.3030	.4450	.6063	B	8267	11737	3470	.70
303	B-28/F/W	23	2-2-84	2.003	.302	.4415	.6049	B	17323(f)	21452	4129	.81
304	B-28/F/W/PC	27	2-1-84	2.0	.3025	.4400	.6050	B	7310(f)	10716	3406	.68
305	B-28/F/W/PC	27	2-1-84	2.0045	.3010	.4405	.6034	B	5548(f)	8163	2615	.68
306	B-28/F/W/PC	27	2-2-84	2.003	.3045	.4410	.6099	B	3141(f)	5916	2775	.53
307	B-28/F/W/PC	27	2-2-84	2.002	.302	.4435	.6046	B	6161(f)	9558	3397	.64
312	B-28/F/D/PC	25	2-2-84	2.0040	.2900	.4415	.5841	B	9650	15693	6043	.61
313	B-28/F/D/PC	25	2-3-84	2.0030	.3070	.4455	.6149	B	7176(f)	14916	7740	.48
314	B-28/F/D/PC	25	2-3-84	2.0065	.3030	.4435	.6079	B	4733	11493	6760	.41
315	B-28/F/D	21	2-6-84	2.0015	.2960	.4435	.5924	B	15752(f)	20853	5101	.76
316	B-28/F/D	21	2-6-84	2.0035	.3010	.4405	.6031	B	22608(f)	26595	3987	.85
317	B-28/F/D	21	2-6-84	2.0015	.2990	.4435	.5985	B	10824(f)	25053	14229	.43
318	B-28/S/W	24	2-6-84	2.0010	.3020	.4415	.6043	B	12038	14676	2638	.82
319	B-28/S/W	24	2-7-84	2.0010	.3050	.4435	.6103	B	6517	10707	4190	.61
320	B-28/S/W	24	2-7-84	1.9985	.3020	.4425	.6035	B	8447	11916	3469	.71
321	B-28/S/W	24	2-7-84	1.9995	.2980	.4435	.5959	B	7140	9975	2835	.72
322	B-28/S/W/PC	28	2-3-84	2.0045	.3030	.4405	.6074	B	6076	8358	2282	.73
323B	B-28/S/W/PC	28	2-24-84	2.0000	.3020	.4415	.6040	B	6097(f)	9453	3356	.64
324	B-28/S/W/PC	28	2-20-84	2.0000	.3035	.4425	.6070	B	21772	24969	3197	.87

Table E1 Summary of Dog-Bone Specimen Spectrum Fatigue Test Results for Task 5 (7075-T7651 Aluminum) (Continued)

SPECIMEN NO.	TEST I.D. (a)	DATA SET NO.	TEST DATE	SPECIMEN DETAILS WIDTH (IN.)	THICK (IN.)	HOLE DIA (IN.)	GROSS AREA (IN^2)	FATIGUE CRACK ORIGIN (b)	TTCI (FLT. HRS.) (c)	TTF (FLT. HRS.) (d)	TTF-TTCI (FLT. HRS.) (e)	TTCI/TTF
325	B-28/S/W/PC	28	2-14-84	2.0010	.3015	.4425	.6033	B	5368(f)	7863	2495	.68
326	B-28/S/D	22	2-13-84	2.0010	.3010	.4425	.6023	B	20143	22716	2573	.89
327	B-28/S/D	22	2-13-84	2.0015	.3010	.4415	.6025	B	21824	24516	2692	.89
328	B-28/S/D	22	2-13-84	2.0000	.3025	.4415	.6050	B	19800	22446	2646	.88
329	B-28/S/D/PC	26	2-21-84	2.0005	.3015	.4465	.6032	B	12797(f)	16116	3319	.79
330	B-28/S/D/PC	26	2-17-84	1.9990	.2950	.4470	.5897	B	15650	18753	3103	.83
331	B-28/S/D/PC	26	2-14-84	1.9990	.2990	.4430	.5977	B	12175(f)	15693	3518	.78
336	A-28/S/W/PC	9	3-1-84	2.0040	.3010	.4415	.6032	B	851	3200	2349	.27
337	A-28/S/W/PC	9	3-9-84	2.001	.3005	.4415	.6013	B	4456	5792	1336	.77
338	A-28/20/S/W/PC	38	3-15-84	1.9990	.2950	.4425	.5897	B	2000	3959	1959	.51
515	C-28/F/D	33	5-10-84	1.9955	.3050	.5030	.6086	B	27709	50100	22391	.55
516	C-28/F/D	33	5-16-84	2.0050	.2955	.5065	.5924	B	10789	31596	20807	.34
517	C-28/F/D	33	5-16-84	1.9935	.2970	.5050	.5920	B	40500(g)	64916	24416	.62
518	C-28/F/W	34	5-17-84	1.9955	.2960	.5030	.5906	C	15300	20400	5100	.75
519	C-28/F/W	34	5-18-84	2.0020	.2945	.5030	.5895	C	4500	19500	15000	.23
520	C-28/F/W	34	5-18-84	2.0045	.3010	.5050	.6033	B	11100	19200	8100	.58

Notes: (a) Ref. Table 8 for description code.
(b) Fatigue crack origins: B = bore of hole, C = corner of hole and S = surface crack away from hole.
(c) Time to initiate crack depth of 0.010" in fastener hole (determined from fractographic results).
(d) Time-to-Failure (TTF)
(e) Time spent in crack growth.
(f) Extrapolation based on power law (Eqs. 1 & 3)
(g) Linear extrapolation.
(h) Testing anomaly
(i) Diameter measurement not recorded.

FATIGUE TEST DATA

SPECIMEN NUMBER: 45 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 5-31-83 //

W 2.0170" TH .3010" HOLE DIAM .4412" A .6071 in^2

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

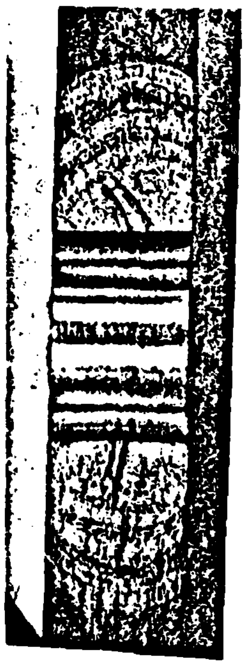
ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 2106423 ldpts % LIFE = 275

TTCI 14000 FLIGHT HOURS

Larger Flaw = .351" B

Smaller Flaw = .349" B



2.5x

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
61	24400	
60	24000	
59	23600	
58	23200	
57	22800	
56	22400	
F 55+	22006	.3510
54	21600	.1970
53	21200	.1505
52	20800	.1245
51	20400	.0990
50	20000	.0815
49	19600	.0635
48	19200	.0530
47	18800	.0445
46	18400	.0410
45	16000	.0355
44	17600	.0305
43	17200	.0265
42	16800	.0235
41	16400	.0205

FATIGUE TEST DATA

SPECIMEN NUMBER: 45 (Open hole)

SPECTRUM: 400hr (A)

TEST DATE: 5-31-83 //

W 2.0170" TH .3010" HOLE DIAM .4412" A .6071in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. Dry PREPS. none

CYCLES TO FAILURE 2106423 1d pts % LIFE = 275

TTCI 14,000 FLIGHT HOURS

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0185
39	15600	.0160
38	15200	.0145
37	14800	.0125
36	14400	.0110
35	14000	.0100
34	13600	.0090
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: 46 (open hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-5-83 //

W 2.0100" TH .3005" HOLE DIAM .4434" A .6040 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

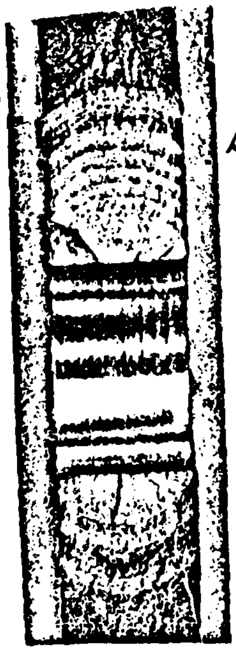
ENVIR. CONDS. Dry PREPS. none

CYCLES TO FAILURE 1534866 Hpts % LIFE = 2.00

TTCI 6600 FLIGHT HOURS

Larger Flaw = .427" B

Smaller Flaw = .180" B



2.5X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F	40	16035	.4270
	39	15600	.3645
	38	15200	.2450
	37	14800	.2125
	36	14400	.1790
	35	14000	.1465
	34	13600	.1170
	33	13200	.0985
	32	12800	.0825
	31	12400	.0690
	30	12000	.0580
	29	11600	.0510
	28	11200	.0455
	27	10800	.0405
	26	10400	.0360
	25	10000	.0325
	24	9600	.0285
	23	9200	.0250
	22	8800	.0225
	21	8400	.0195
	20	8000	.0180
	19	7600	.0155
	18	7200	.0130
TTCI →	17	6800	.0110
	16	6400	.0090
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 62 (open hole)

SPECTRUM: 400hr (A)

TEST DATE: 6-22-83 //

W 2.0110" TH .3025 HOLE DIAM .4380" A .6083 in^2

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

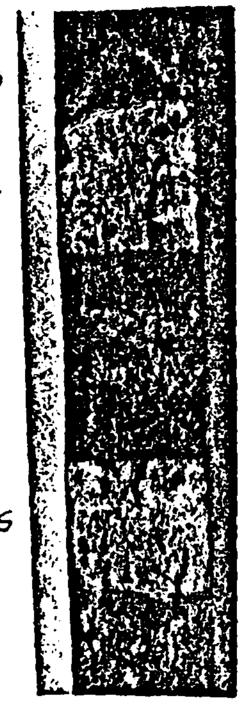
ENVIR. CONDS. 3.5% NaCl PREPS. none F

CYCLES TO FAILURE 1151992 ld pts % LIFE = 150

TTCI 5872 FLIGHT HOURS

Larger Flaw = .3515" B

Smaller Flaw = .282" B L



2.48X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	.3515
29	11600	.2150
28	11200	.1470
27	10800	.1130
26	10400	.0890
25	10000	.0805
24	9600	.0730
23	9200	.0640
22	8800	.0565
21	8400	.0515
20	8000	.0410
19	7600	.0310
18	7200	.0250
17	6800	.0205
16	6400	.0145
15	6000	.0110
14	5600	.0080
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 67 (open hole)

SPECTRUM: 400hr (A)

TEST DATE: 7-1-83 // F

W 2.0120" TH .3050 HOLE DIAM .4427" A .6137 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (Slow) FM=40

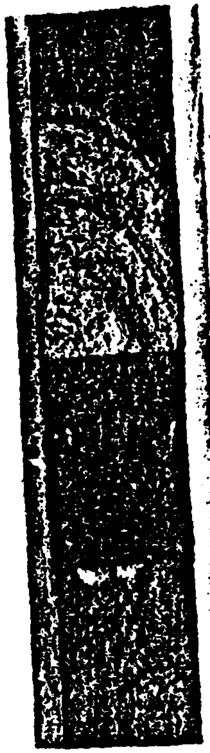
ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 1419995 ld. pts. % LIFE ≐ 185

TTCI 7531 FLIGHT HOURS

Larger Flaw = .5320" C

Smaller Flaw = .04" B


2.54X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	.5320
36	14400	.3560
35	14000	.2495
34	13600	.1930
33	13200	.1540
32	12800	.1190
31	12400	.0920
30	12000	.0700
29	11600	.0540
28	11200	.0460
27	10800	.0375
26	10400	.0310
25	10000	.0250
24	9600	.0200
23	9200	.0175
22	8800	.0160
21	8400	.0135*
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

last readable block marker before flaw
* unintentional Original flaw at .0115

FATIGUE TEST DATA

SPECIMEN NUMBER: 71 (open hole)

SPECTRUM: 400hr (A)

TEST DATE: 7-13-83 //

W 2.005" TH .3040" HOLE DIAM .4455 A .6095 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 728068 ld. pts. % LIFE ≐ 95

TTCI 1600 FLIGHT HOURS

Smaller Flaw = .158" B

Larger Flaw = .4915" C

L

S

2.53X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
F 19	7600	.4915
18	7200	.3300
17	6800	.2025
16	6400	.1350
15	6000	.0990
14	5600	.0775
13	5200	.0590
12	4800	.0485
11	4400	.0425
10	4000	.0345
9	3600	.0290
8	3200	.0250
7	2800	.0215
6	2400	.0170
5	2000	.0130
mi → 4	1600	.010
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 72 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 7-21-83 //

W 1.9980" TH .2915" HOLE DIAM .4440" A .5824 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (slow)

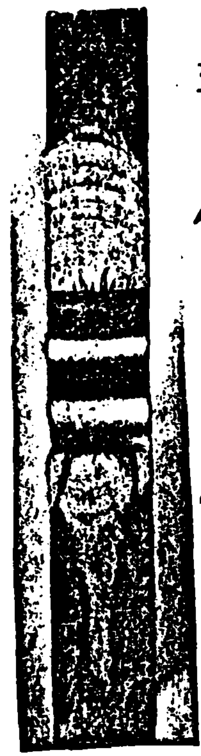
ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 1573153 kl.pts % LIFE = 205

TTCI 8471 FLIGHT HOURS

Larger Flaw = .4520" B

Smaller Flaw = .150" B



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	.3670
	39	15600	.3200
	38	15200	.2660
	37	14800	.2175
	36	14400	.1605
	35	14000	.1265
	34	13600	.0985
	33	13200	.0810
	32	12800	.0620
	31	12400	.0510
	30	12000	.0435
	29	11600	.0375
	28	11200	.0330
	27	10800	.0270
	26	10400	.0230
	25	10000	.0200
	24	9600	.0170
	23	9200	.0140
TTCI →	22	8800	.0120
	21	8400	.0095
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
F	41.08	16,400	.4520

FATIGUE TEST DATA

SPECIMEN NUMBER: 76 (open hole)

SPECTRUM: 400hr (A)

TEST DATE: 7-5-83 //

W 1.9990" TH .3045 HOLE DIAM .4395" A .6087 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 1340057 ld pts % LIFE = 175

TTCI 8000 FLIGHT HOURS

Larger Flaw = .5825" B

Smaller Flaw = .075" C, B

L

S

2.53X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
F35	14000	.5825
34	13600	.4320
33	13200	.3065
32	12800	.2130
31	12400	.1535
30	12000	.0970
29	11600	.0620
28	11200	.0445
27	10800	.0335
26	10400	.0275
25	10000	.0225
24	9600	.0185
23	9200	.0150
22	8800	.0135
21	8400	.0115
TTCI 20	8000	.0100
19	7600	.0085
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 77 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 8-1-83 //

W 2.0105" TH .3030" HOLE DIAM .4395" A .6092 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

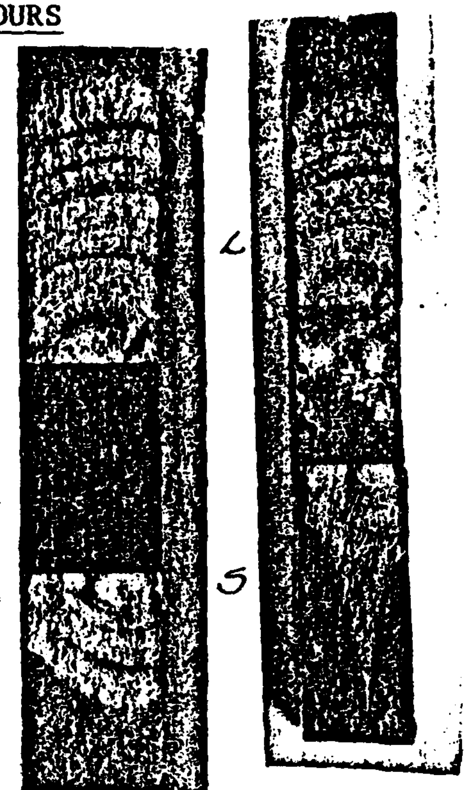
ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 2100916 ld pts % LIFE = 274

TTCI 16,400 FLIGHT HOURS

Larger Flaw = .6030" B

Smaller Flaw = .300" B



2.7X 2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	—	....	—
F	54.87	21,948	.6030
	53	21,200	.2880
	52	20,800	.1465
	51	20,400	.0910
	50	20,000	.0665
	49	19,600	.0595
	48	19,200	.0360
	47	18,800	.0300
	46	18,400	.0245
	45	18,000	.0205
	44	17,600	.0180
	43	17,200	.0145
	42	16,800	.0120
TTCI	41	16,400	.0100

FATIGUE TEST DATA

SPECIMEN NUMBER: 79 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 8-11-83 //

W 2.0065" TH .3045" HOLE DIAM .4435" A .6110 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2days (Fast)

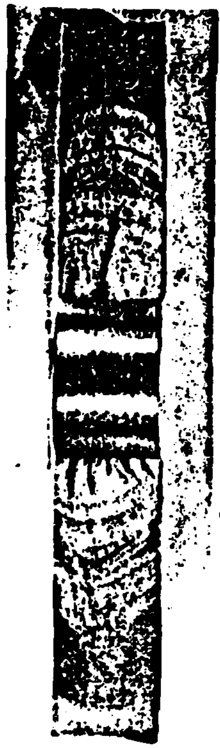
ENVIR. CONDS. Dry PREPS.

CYCLES TO FAILURE 1680664 ld pts % LIFE = 219

TTCI 10,600 FLIGHT HOURS

Larger Flow - .5410" B

Smaller Flow - .450" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.1470
39	15600	.1200
38	15200	.0925
37	14800	.0795
36	14400	.0640
35	14000	.0500
34	13600	.0375
33	13200	.0310
32	12800	.0265
31	12400	.0225
30	12000	.0195
29	11600	.0165
28	11200	.0130
27	10800	.0110
26	10400	.0090
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
F 43.9	17,560	.5410
43	17200	.3575
42	16800	.2420
41	16400	.1890

TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: 81 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 8-17-83 //

W 2.0095" TH .3025" HOLE DIAM .4395" A .6079 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 646077 ld pts % LIFE = 84

TTCI 3434 FLIGHT HOURS

Larger Flaw = .6145" B

Smaller Flaw = .175" B

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
F	16.874	6750	.6145
	16	6400	.2785
	15	6000	.1445
	14	5600	.0820
	13	5200	.0500
	12	4800	.0330
	11	4400	.0230
	10	4000	.0165
	9	3600	.0120
TTCI →	8	3200	.0070
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 82 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 8-18-83 //

W 2.0120' TH .3020' HOLE DIAM .4395" A .6076 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. ——

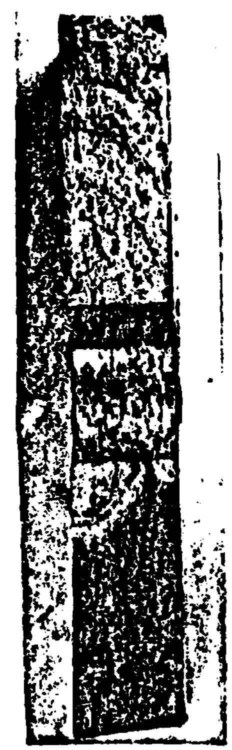
CYCLES TO FAILURE 1151991 ldpts % LIFE = 150

TTCI 6700 FLIGHT HOURS

Larger Flaw = .6245" C

Smaller Flaw = .210" C

L



S

2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
F	30 .088	12000	.6245
	29	11600	.3230
	28	11200	.2405
	27	10800	.1705
	26	10400	.1120
	25	10000	.0870
	24	9600	.0640
	23	9200	.0480
	22	8800	.0365
	21	8400	.0285
	20	8000	.0220
	19	7600	.0160
	18	7200	.0125
	17	6800	.0105
TTCI →	16	6400	.0085
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 83 (Open Hole)

SPECTRUM: 400 hr (A)

TEST DATE: 8-22-83 //

W 2.0030" TH .3030" HOLE DIAM .4395" A .6069 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days = Slow

ENVIR. CONDS. Dry PREPS. none

CYCLES TO FAILURE 3223534 ld pts % LIFE = 421

TTCI 25,200 FLIGHT HOURS

Larger Flaw = .4030" B

Smaller Flaw = .350" B

L

S

2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	80	32000	.115
	79	31600	.0945
	78	31200	.0645
	77	30800	.0490
	76	30400	.0440
	75	30000	.0350
	74	29600	.0290
	73	29200	.0250
	72	28800	.0220
	71	28400	.0200
	70	28000	.0185
	69	27600	.0170
	68	27200	.0150
	67	26800	.0135
	66	26400	.0125
	65	26000	.0115
	64	25600	.0110
TTCI →	63	25200	.0100
	62	24800	
	61	24400	
	60	24000	
	59	23600	
	58	23200	
	57	22800	
	56	22400	
	55	22000	
	54	21600	
	53	21200	
	52	20800	
	51	20400	
	50	20000	
	49	19600	
	48	19200	
	47	18800	
	46	18400	
F	84.194	33,677.6	.4030
	83	33,200	.2295
	82	32,800	.1830
	81	32,400	.1440

FATIGUE TEST DATA

SPECIMEN NUMBER: 84 (open hole)

SPECTRUM: F16-400hr (A)

TEST DATE: 9-12-83 //

W 2.002" TH .3020" HOLE DIAM .4440" A .6046 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 3 months

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 979042 ld pts % LIFE = 128

TTCI 8063 FLIGHT HOURS

Larger Flaw = .5490" B

Smaller Flaw = .225" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
F 25.5T	10240	.5490
25	10000	—
24	9600	.1305
23	9200	.0720
22	8800	.0410
21	8400	.0180
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 85 (open hole)

SPECTRUM: F16-400hr (A)

TEST DATE: 9-20-83 //

W 2.0025" TH .2880" HOLE DIAM .4430" A .5767in²

MAX STRESS 28ksi FREQ. 1 LIFE = 3 months

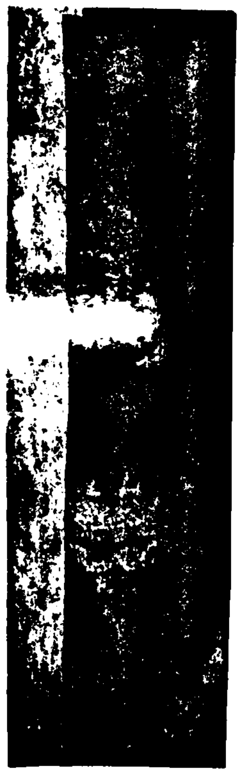
ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 998361 ld pts % LIFE = 130

TTCI 8160 FLIGHT HOURS

Larger Flaw = .4335" B

Smaller Flaw = .325" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	.4335
25	10000	.2045
24	9600	.1125
23	9200	.0615
22	8800	.0315
21	8400	.0155
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 86 (open hole)

SPECTRUM: F16-400hr (A)

TEST DATE: 9-20-83 //

W 2.0085" TH .3010" HOLE DIAM .4443" A .6045 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 3 months

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 1187528 ld pts % LIFE ≐ 155

TTCI 8178 FLIGHT HOURS

Smaller Flaw = .175" B

Larger Flaw = .5535" B

86

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
F 31	12400	.5535
30	12000	.3645
29	11600	.2700
28	11200	.1890
27	10800	.1320
26	10400	.0930
25	10000	—
24	9600	.0520
23	9200	.0280
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 87 (open hole)

SPECTRUM: F16-400hr (A)

TEST DATE: 10-06-83 //

W 2.0005" TH .3025" HOLE DIAM .4410" A .6052 in²

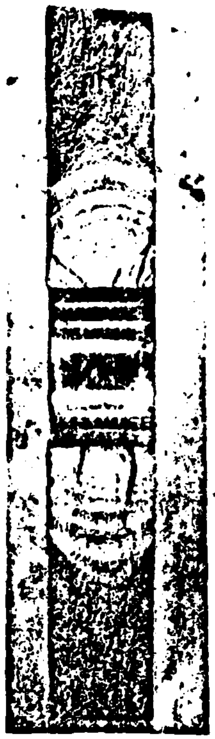
MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days Slow (FM=40)

ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 2377183 Id pts. % LIFE = 310

TTCI 16,800 FLIGHT HOURS

Large Flaw = .3915" B
Smaller Flaw = .375" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
F 62	24800	.3915
61	24400	.2910
60	24000	.2265
59	23600	.1880
58	23200	.1530
57	22800	.1295
56	22400	.1090
55	22000	.0910
54	21600	.0780
53	21200	.0665
52	20800	.0580
51	20400	.0505
50	20000	.0445
49	19600	.0420
48	19200	.0380
47	18800	.0330
46	18400	.0290
45	18000	.0250
44	17600	.0185
43	17200	.0135
TTCI 42	16800	.0100
41	16400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 88 (open hole)

SPECTRUM: F16-400hr(A)

TEST DATE: 11-08-83 //

W 2.00" TH .3010" HOLE DIAM .440" A .6020 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days, Slow (FM=40)

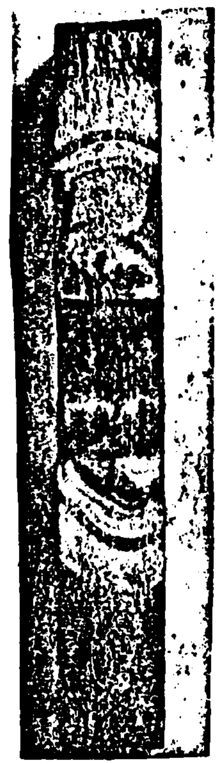
ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 1442846 ld pts % LIFE ≐ 188

TTCI 12554 FLIGHT HOURS

Larger Flaw = .605"B

Smaller Flaw = .375"B



2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	15040 F	.605
36	14400	.180
35	14000	.099
34	13600	.052
33	13200	.033
32	12800	.014
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 89 (open hole)

SPECTRUM: F16-400 hr (A)

TEST DATE: 11-03-83 //

W 2.006" TH .3045" HOLE DIAM — A .6108 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days Fast (FH=250)

ENVIR. CONDS. Dry Air PREPS. —

CYCLES TO FAILURE 3140181 ld pts % LIFE = 410

TTCI 21,600 FLIGHT HOURS

Larger Flaw = .4705" B

Smaller Flaw = .250" B

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	.3105
79	31600	.2595
78	31200	.2250
77	30800	.1975
76	30400	.1770
75	30000	.1495
74	29600	.1230
73	29200	.1025
72	28800	.0930
71	28400	.0765
70	28000	.0610
69	27600	.0510
68	27200	.0440
67	26800	.0400
66	26400	.0350
65	26000	.0315
64	25600	.0285
63	25200	.0250
62	24800	.0230
61	24400	.0205
60	24000	.0185
59	23600	.0165
58	23200	.0150
57	22800	.0135
56	22400	.0125
55	22000	.0110
TTCI → 54	21600	.0100
53	21200	
52	20800	
51	20400	
50	20000	
49	19600	
48	19200	
47	18800	
46	18400	
45	18000	
44	17600	
—	—	—
F 82	32,800	.4705
81	32,400	.3780

FATIGUE TEST DATA

SPECIMEN NUMBER: 90 (open hole)

SPECTRUM: F16-400hr(A)

TEST DATE: 11-03-83 //

W 2.013" TH .3040" HOLE DIAM — A .6119 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16days (Slow) FM=40

ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 2070877 ld pts % LIFE = 270

TTCI 15226 FLIGHT HOURS

Larger Flaw = .548" C

Smaller Flaw = .075" B,C

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
61	24400	
60	24000	
59	23600	
58	23200	
57	22800	
56	22400	
55	22000	
54	21600	.548
53	21200	.300
52	20800	.168
51	20400	.0970
50	20000	.0685
49	19600	.0510
48	19200	.0365
47	18800	.0305
46	18400	.0280
45	18000	.0250
44	17600	.0220
43	17200	.0195
42	16800	
41	16400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 91

SPECTRUM: F16-400hr(A)

TEST DATE: 11-03-83 //

W 2.006" TH .303" HOLE DIAM — A .6078 in²

MAX STRESS 28 KSI FREQ 1 LIFE = 16 days (Slow)

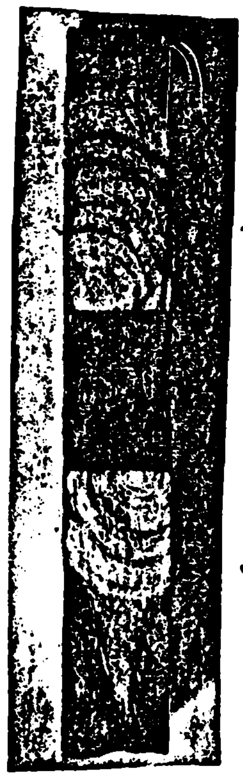
ENVIR. CONDS. 3.5% NaCl PREPS. —

CYCLES TO FAILURE 1749361 ld pts % LIFE = 228

TTCI 9400 FLIGHT HOURS

Smaller Flaw = .375" B

Larger Flaw = .619" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0870
39	15600	.0680
38	15200	.0560
37	14800	.0490
36	14400	.0415
35	14000	.0360
34	13600	.0330
33	13200	.0270
32	12800	.0240
31	12400	.0220
30	12000	.0205
29	11600	.0190
28	11200	.0170
27	10800	.0150
26	10400	.0130
25	10000	.0110
24	9600	.0105
TTCI → 23	9200	.0095
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
—	—	—
F 45.6	18240	.6190
4	17600	.2915
3	17200	.2230
2	16800	.1610
1	16400	.1135

FATIGUE TEST DATA

SPECIMEN NUMBER: 92 (open hole)

SPECTRUM: F16-400hr

TEST DATE: 12-05-83 //

W 2.009" TH .301" HOLE DIAM .4135" A .6047 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (Slow) FM=40

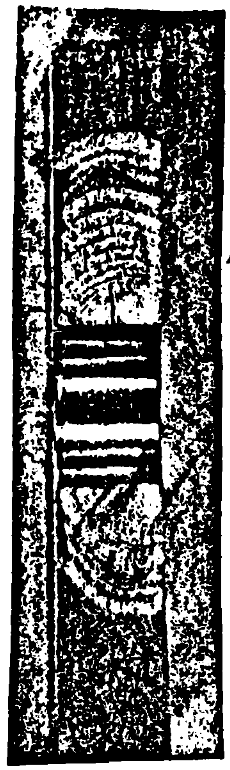
ENVIR. CONDS. Dry Air PREPS. —

CYCLES TO FAILURE 2324003 % LIFE = 303

TTCI 13249 FLIGHT HOURS

Larger Flaw = .5235" B

Smaller Flaw = .350" C



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16,000	—
39	15,600	—
39	15,200	T .0160
37	14,800	I .0150
—	—	—
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
—	—	—
60.6	24,240	.5235
59	23600	.3440
58	23200	.2840
57	22800	.2465
56	22400	.2110
55	22000	.1765
54	21600	.1505
53	21200	.1300
52	20800	.1070
51	20400	.0900
50	20000	.0750
49	19600	.0630
48	19200	.0530
47	18800	.0460
46	18400	.0400
45	18000	.0350
44	17600	.0305
43	17200	.0280
42	16800	—
41	16400	—

FATIGUE TEST DATA

SPECIMEN NUMBER: 101 (20% LT)

SPECTRUM: 400hr(A)

TEST DATE: 8-23-83 //

W 2.0065" TH .2990" HOLE DIAM .4380" A .5999 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

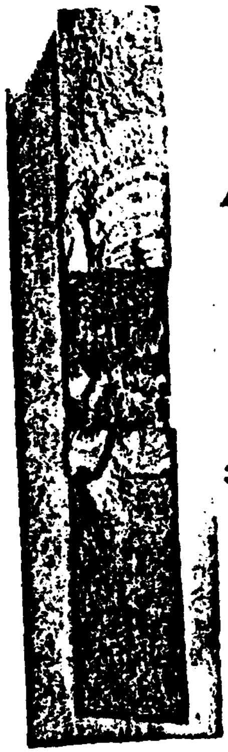
ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 574937 ld pts % LIFE ≈ 75

TTCI 3775 FLIGHT HOURS

Smaller Flaw: .300" B

Larger Flaw: .428" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	.4280
14	5600	.1685
13	5200	.0995
12	4800	.0580
11	4400	.0345
10	4000	.0160
9	3600	.0060
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 102 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 8-16-83 //

W 2.0065" TH .3010" HOLE DIAM .4370" A .6039 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 462815 ld pts % LIFE = 60

TTCI 1622 FLIGHT HOURS

Smaller Flaw = .175" B

Larger Flaw = .4515" B

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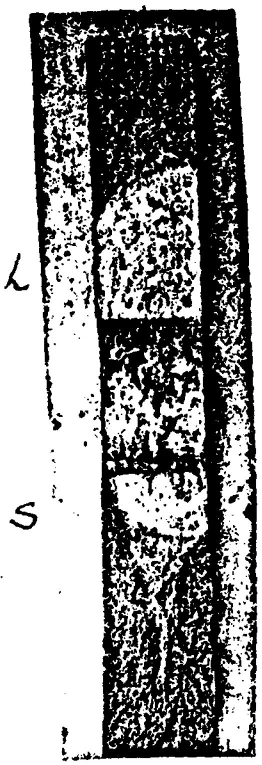

2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
	13	5200	
F	12.088	4800	.4515
	11	4400	.2120
	10	4000	.1400
	9	3600	.0810
	8	3200	.0500
	7	2800	.0370
	6	2400	.0240
TTCI	5	2000	.0175
	4	1600	.0095
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 103 (Open)

SPECTRUM: 400 hr (A)

TEST DATE: 8-17-83 //

W 2.0090" TH .3025" HOLE DIAM .4395" A .6077 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. Dry PREPS. PC

CYCLES TO FAILURE 2606899 ldpts % LIFE = 340 F

TTCI 10,800 FLIGHT HOURS

Smaller Flaw = .225" B

Larger Flaw = .4385" C.B

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	[illegible]00	
69	600	
68.088	27200	.4385
67	26800	.3520
66	26400	.3045
65	26000	.2780
64	25600	.2555
63	25200	.2285
62	24800	.2125
61	24400	.1970
60	24000	.1685
59	23600	.1500
58	23200	.1340
57	22800	.1185
56	22400	.1070
55	22000	.0965
54	21600	.0870
53	21200	.0780
52	20800	.0710
51	20400	.0660
50	20000	.0595
49	19600	.0540
48	19200	.0505
47	18300	.0465
46	18400	.0422
45	18000	.0382
44	17600	.0352
43	17200	.0325
42	16800	.0300
41	16400	.0273

FATIGUE TEST DATA

SPECIMEN NUMBER: 103 (continued)

SPECTRUM: ____________

TEST DATE: ________//________

W________ TH________ HOLE DIAM________ A________

MAX STRESS________ FREQ.____ 1 LIFE = ________

ENVIR. CONDS.________ PREPS.________

CYCLES TO FAILURE ________ % LIFE = TTCI

TTCI ________ FLIGHT HOURS

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0253
39	15600	.0230
38	15200	.0210
37	14800	.0196
36	14400	.0181
35	14000	.0168
34	13600	.0154
33	13200	.0144
32	12800	.0134
31	12400	.0125
30	12000	.0118
29	11600	.0114
28	11200	.0107
27	10800	.0100
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 104 (20% LT)

SPECTRUM: 400hr (A)

TEST DATE: 8-24-83 //

W 2.0045" TH .2990" HOLE DIAM .4380" A .5993 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl* PREPS. Pc

CYCLES TO FAILURE 531209 ld pts % LIFE = 69

TTCI 2812 FLIGHT HOURS

Smaller Flaw = .213" B

Larger Flaw = .5625" B

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
F 13.81	5550	.5625
13	5200	.4435
12	4800	.2965
11	4400	.1480
10	4000	.0860
9	3600	.0400
TTCI 8	3200	.0260
7	2800	.0095
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

* may have had combination : salt-water/desiccant

FATIGUE TEST DATA

SPECIMEN NUMBER: 105

SPECTRUM: 400hr (A)

TEST DATE: 8-24-83 //

W 2.0125" TH .3040" HOLE DIAM .4395" A .6118 in²

MAX STRESS 28 KSI FREQ 1 LIFE = 2 days (Fast)

ENVIR. CONDS. Dry PREPS. PC

CYCLES TO FAILURE 1914997 ld pts % LIFE = 250

TTCI 6651 FLIGHT HOURS

Smaller Flow = .130" B

Larger Flow = .4695" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.1465
39	15600	.1340
38	15200	.1230
37	14800	.1120
36	14400	.1030
35	14000	.0885
34	13600	.0765
33	13200	.0660
32	12800	.0555
31	12400	.0470
30	12000	.0415
29	11600	.0375
28	11200	.0325
27	10800	.0290
26	10400	.0255
25	10000	.0230
24	9600	.0200
23	9200	.0185
22	8800	.0160
21	8400	.0150
20	8000	.0135
19	7600	.0125
18	7200	.0115
17	6800	.0105
TTCI 16	6400	.0080
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
F 50.016	20006	.4695
49	19600	.4010
48	19200	.3490
47	18800	.3105
46	18400	.2490
45	18000	.2460
44	17600	.2190
43	17200	.2230
42	16800	.1765
41	16400	.1600

FATIGUE TEST DATA

SPECIMEN NUMBER: 106 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 8-24-83 //

W 2.0025" TH .3030" HOLE DIAM .4395" A .6067 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. Dry PREPS. — PC

CYCLES TO FAILURE 1034374 k pts % LIFE = 135

TTCI 2800 FLIGHT HOURS

Smaller Flaw = .050" c,B

Larger Flaw = .5120" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27.016	10806	.5120
26	10400	.3780
25	10000	.3330
24	9600	.2970
23	9200	.2625
22	8800	.2265
21	8400	.1925
20	8000	.1625
19	7600	.1310
18	7200	.1035
17	6800	.0760
16	6400	.0620
15	6000	.0495
14	5600	.0415
13	5200	.0350
12	4800	.0280
11	4400	.0225
10	4000	.0185
9	3600	.0155
8	3200	.0135
7	2800	.0100
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 107 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 8-25-83 //

W 2.0045" TH .3035" HOLE DIAM .4395" A .6083 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 651498 ld pts % LIFE = 85

TTCI 1600 FLIGHT HOURS

Smaller Flaw = .075" B

Larger Flaw = .567" B

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	—	—	—
F	17.016	6806	.5670
	16	6400	.2990
	15	6000	.2020
	14	5600	.1320
	13	5200	.0835
	12	4800	.0535
	11	4400	.0405
	10	4000	.0320
	9	3600	.0260
	8	3200	.0210
	7	2800	.0180
	6	2400	.0150
	5	2000	.0120
TTCI	4	1600	.0100
	—	—	—
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 108 (Open)

SPECTRUM: 400hr (A)

TEST DATE: 8-26-83 //

W 2.0045" TH .3030" HOLE DIAM .4395" A .6074 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2days (Fast)

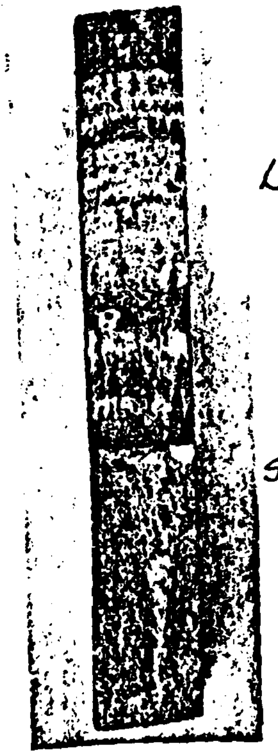
ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 401239 ld pts % LIFE = 52

TTCI 1097 FLIGHT HOURS

Smaller Flaw = .050" C

Larger Flaw = .660" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10 AE	4192	.6600
9	3600	.2720
8	3200	.1130
7	2800	.0540
6	2400	.0325
5	2000	.0225
4	1600	.0165
3	1200	.0110
2	800	.0075
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 109 (Open Hole)

SPECTRUM: 400hrs(A)

TEST DATE: 8-26-83 //

W 2.0055" TH .3030" HOLE DIAM .4395" A .6076in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow)

ENVIR. CONDS. Dry PREPS. P.C.

CYCLES TO FAILURE 4172937 ld pts % LIFE = 54.5

TTCI 28000 FLIGHT HOURS

Smaller Flaw = .300" c

Larger Flaw = .443" c

2X

CTOGRAPHIC DATA

BLK #		CRACK LENGTH IN.
108.99	43596	.443
108	43200	.369
107	42800	.310
106	42400	.265
105	42000	.2305
104	41600	.2055
103	41200	.181
102	40800	.163
101	40400	.149
100	40000	.136
99	39600	.125
98	39200	.114
97	38800	.106
96	38400	.095
95	38000	.0885
94	37600	.082
93	37200	.075
92	36800	.0695
91	36400	.067
90	36000	.063
89	35600	.059
88	35200	.056
87	34800	.051
86	34400	.0465
85	34000	.045
84	33600	.0415
83	33200	.038
82	32800	.036
81	32400	.034
80	32000	.033
79	31600	.031
78	31200	.030
—	—	—
—	—	—
—	—	—
—	—	—
73	29200	.023
—	—	—
—	—	—
TTCI → 63	28000	.010

FATIGUE TEST DATA

SPECIMEN NUMBER: 110 (Open Hole)

SPECTRUM: 400hr (A)

TEST DATE: 8-30-83 //

W 2.0120" TH .3045 HOLE DIAM .4395 A .6126in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days (Slow)

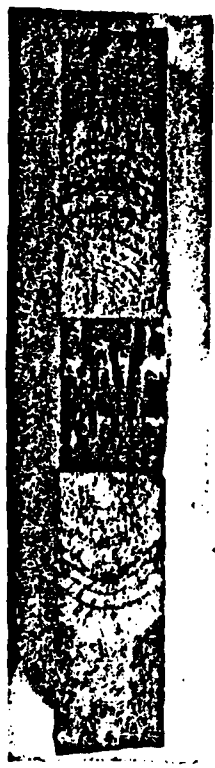
ENVIR. CONDS. Dry PREPS. pre-cond.

CYCLES TO FAILURE 2989771 ld. pts. % LIFE = 390

TTCI 18,400 FLIGHT HOURS

Smaller Flaw = .475" B

Larger Flaw = .570" B



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	80	32000	
	79	31600	
F	78.08	31235	.570
	77	30800	.3030
	76	30400	.257
	75	30000	.219
	74	29600	.190
	73	29200	.168
	72	28800	.147
	71	28400	.129
	70	28000	.113
	69	27600	.099
	68	27200	.086
	67	26800	.075
	66	26400	.066
	65	26000	.057
	64	25600	.051
	63	25200	.0445
	62	24800	.040
	61	24400	.037
	60	24000	.033
	59	23600	.031
	58	23200	.027
	57	22800	.0255
	56	22400	.0240
	55	22000	.0215
	54	21600	.020
	53	21200	.0175
	52	20800	.0165
	51	20400	.0150
	50	20000	.0140
	49	19600	.0130
	48	19200	.0120
	47	18800	.0110
TTCI →	46	18400	.0100
	45	18000	
	44	17600	
	43	17200	
	42	16800	
	41	16400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 112 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 10-28-83 //

W 2.003" TH .303" HOLE DIAM .4415" A .6069 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. P.C

CYCLES TO FAILURE 922257 % LIFE = 120

TTCI 3120 FLIGHT HOURS

Smaller Flaw = .575" B

Larger Flaw = .6030" B

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
F 24.08	9635	.6030
23	9200	.3970
22	8800	.2780
21	8400	.2240
20	8000	.1435
19	7600	.1030
18	7200	.0810
17	6800	.0600
16	6400	.0465
15	6000	.0350
14	5600	.0290
13	5200	.0250
12	4800	.0215
11	4400	.0180
10	4000	.0155
9	3600	.0130
8	3200	.0105
TTCI → 7	2800	.0080
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 113 (Open Hole)

SPECTRUM: 400hr(A)

TEST DATE: 9-2-83 //

W 2.0020" TH .3045" HOLE DIAM .4400" A .6096 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 weeks (Slow) FM=40

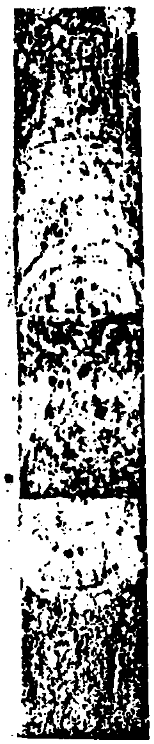
ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 268626 14 pts % LIFE = 35

TTCI 875 FLIGHT HOURS

Smaller Flaw = .300" B

Larger Flaw = .6145" B



2X

L

S F

TTCI

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7016	2806	.6145
6	2400	.1640
5	2000	.0695
4	1600	.0260
3	1200	.0165
2	800	.0085
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 114 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 10-31-83 //

W 2.004" TH .3015" HOLE DIAM .4390' A .6042 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. 3.5% Nacl PREPS. p.c.

CYCLES TO FAILURE 957186 ld pts % LIFE = 125

TTCI 2323 √FLIGHT HOURS

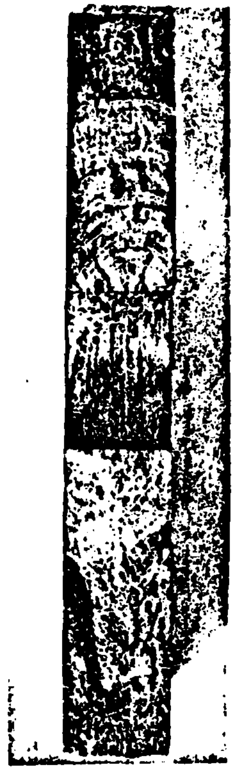
Smaller Flaw = .300" B

Larger Flaw = .5180" B

F

L

S



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	.5180
24	9600	.3530
23	9200	.2360
22	8800	.1640
21	8400	.1185
20	8000	.0850
19	7600	.0685
18	7200	.0550
17	6800	.0445
16	6400	.0410
15	6000	.0365
14	5600	.0315
13	5200	.0280
12	4800	.0245
11	4400	.0230
10	4000	.0190
9	3600	.0170
8	3200	.0150
7	2800	.0125
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 115 (Open Hole)

SPECTRUM: 400 hr (A)

TEST DATE: 9-12-83 //

W 2.0110" TH .3035" HOLE DIAM .4395" A .6103 in²

MAX STRESS 28 FREQ. 1 LIFE = 2 weeks (Slow)

ENVIR. CONDS. 3.5% NaCl PREPS. PC

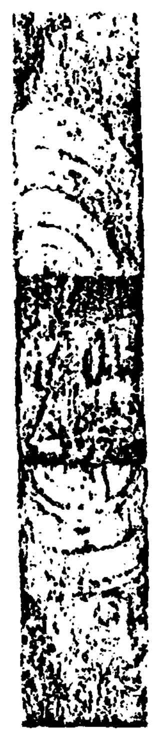
CYCLES TO FAILURE 693464 H pts % LIFE = 91

TTCI 4440 FLIGHT HOURS

Smaller Flaw = .324"B

Larger Flaw = .3955'B

L



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2.31X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
F 18.112	7245	.3955
17	6800	.1325
16	6400	.0795
15	6000	.0510
14	5600	.0350
13	5200	.0210
TTCI 12	4800	.0145
11	4400	.0095
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 116 (Bolt-In)

SPECTRUM: F16-400hr(A)

TEST DATE: 10-31-83 //

W 2.0095" TH .3015" HOLE DIAM .4395" A .6059 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. pc.

CYCLES TO FAILURE 1037123 1d pts % LIFE = 135 F

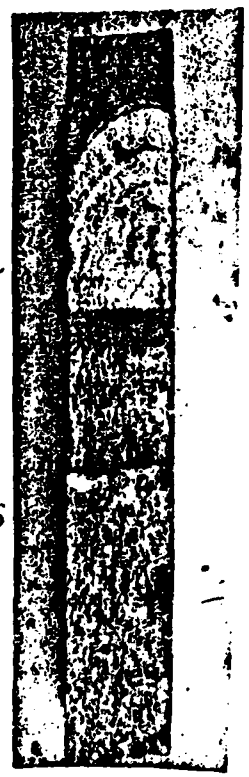
TTCI 4549 FLIGHT HOURS

Smaller Flaw = .050" B

Larger Flaw = .5660" C

L

S



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10835	.5660
26	10400	—
25	10000	.3625
24	9600	.2820
23	9200	.2155
22	8800	.1600
21	8400	.1110
20	8000	.0760
19	7600	.0485
18	7200	.0400
17	6800	.0310
16	6400	.0245
15	6000	.0210
14	5600	.0180
13	5200	.0145
12	4800	.0120
11	4400	.0085
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: 117

SPECTRUM: F16-400hr(A)

TEST DATE: 12-9-83 //

W 2.009" TH .3010" HOLE DIAM. ____ A .6047 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 16 days - Slow - FM=40

ENVIR. CONDS. Dry Air PREPS. PC

CYCLES TO FAILURE 3062988 % LIFE = 400

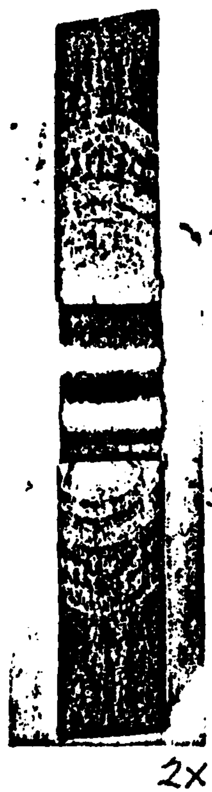
TTCI 23,600 FLIGHT HOURS

Larger Flaw = .526" B

Smaller Flaw = .423" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F 80	32000	
79	31600	
78	31200	.435
77	30800	.288
76	30400	.230
75	30000	.195
74	29600	.164
73	29200	.135
72	28800	.120
71	28400	.107
70	28000	.098
69	27600	.088
68	27200	.078
67	26800	.070
66	26400	.060
65	26000	.047
64	25600	.040
63	25200	.034
62	24800	.027
61	24400	.022
60	24000	.0185
TTCI → 59	23600	.0135
58	23200	.010
57	22800	
56	22400	
55	22000	
54	21600	
53	21200	
52	20800	
51	20400	
50	20000	
49	19600	
48	19200	
47	18800	
46	18400	
45	18000	
44	17600	
43	17200	
42	16800	
41	16400	



FATIGUE TEST DATA

SPECIMEN NUMBER: 122 (Bolt-In) F

SPECTRUM: 400hr (A)

TEST DATE: 10-18-83 //

W 1.9983" TH .304" HOLE DIAM .4415" A .6075 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days - Fast (FM-250)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 1532116 ld pts % LIFE = 200

TTCI 3200 FLIGHT HOURS

Larger Flaw = .549" B

Smaller Flaw = .213" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16006	.5490
39	15600	.4065
38	15200	.3100
37	14800	.2355
36	14400	.1850
35	14000	.1515
34	13600	.1250
33	13200	.1020
32	12800	.0830
31	12400	.0695
30	12000	.0590
29	11600	.0535
28	11200	.0480
27	10800	.0430
26	10400	.0380
25	10000	.0340
24	9600	—
23	9200	—
22	8800	—
21	8400	—
20	8000	.022
19	7600	.020
18	7200	—
17	6800	—
16	6400	—
15	6000	—
14	5600	.0155
13	5200	—
12	4800	—
11	4400	—
10	4000	—
9	3600	—
TTCI → 8	3200	.0100
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 123 (Bolt-In)

SPECTRUM: 400hr (A)

TEST DATE: 10-21-83 //

W 2.0090" TH .3040" HOLE DIAM .4410" A .6107 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast) FH=250

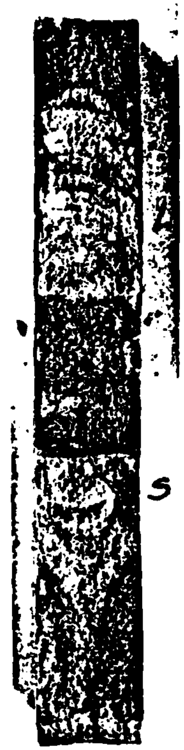
ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 1809316 ld pts % LIFE = 236

TTCI 13,868 FLIGHT HOURS

Larger Flaw = .5745" B

Smaller Flaw = .250" B



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	.0220
	39	15600	.0195
	38	15200	.0160
	37	14800	.0140
	36	14400	.0120
TTCI →	35	14000	.0105
	34	13600	.0090
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
	15	6000	
	14	5600	
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	—	—	—
F	47.25	18902	.5745
	47	18800	.3925
	46	18400	.2475
	45	18000	.1540
	44	17600	.0915
	43	17200	.0660
	42	16800	.0460
	41	16400	.0355

FATIGUE TEST DATA

SPECIMEN NUMBER: 124 (Bolt-In)

SPECTRUM: F16-400hr(A)

TEST DATE: 10-25-83 //

W 2.008" TH .3015" HOLE DIAM .4435" A .6054 in²

MAX STRESS 28 ksi FREQ 1 LIFE = 2days (Fast FM-250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

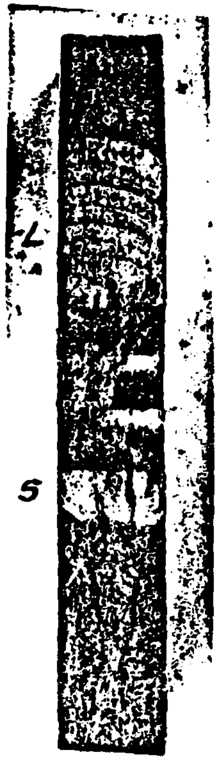
CYCLES TO FAILURE 1608687 ld pts % LIFE ≐ 210

TTCI 11,600 FLIGHT HOURS

Larger Flaw = .4760"B

Smaller Flaw = .150"B

L



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2X

F

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.2510
39	15600	.1640
38	15200	.0965
37	14800	.0550
36	14400	.0400
35	14000	.0315
34	13600	.0250
33	13200	.0210
32	12800	.0175
31	12400	.0145
30	12000	.0120
29 (TTCI →)	11600	.0100
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
—	—	
42	16806	.4760
1	16400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 125 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 10-28-83 //

W 2.003" TH .303" HOLE DIAM .4405" A .6069in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast)

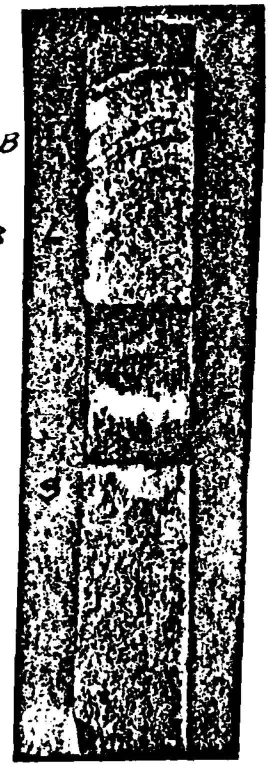
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 991497 ld pts. % LIFE = 129

TTCI 5777 FLIGHT HOURS

Larger Flaw = .6545B

Smaller Flaw = .100"B



2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
F	25.89	10356	.6545
	24	9600	.3355
	23	9200	.2275
	22	8800	.1535
	21	8400	.0930
	20	8000	.0510
	19	7600	.0405
	18	7200	.0345
	17	6800	.0245
	16	6400	.0180
	15	6000	.0130
TTCI →	14	5600	.0075
	13	5200	
	12	4800	
	11	4400	
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 126 (Bolt-In)

SPECTRUM: F16-400hr(A)

TEST DATE: 11-28-83 //

W 2.009" TH .304" HOLE DIAM .4435" A .6099 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast)

ENVIR. CONDS. Dry Air PREPS. No

CYCLES TO FAILURE 3449232 ldpts% LIFE = 450

TTCI 23,600 FLIGHT HOURS

Larger Flaw = .379"B

Smaller Flaw = .25c"B

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	.062
79	31600	.0545
78	31200	.049
77	30800	.046
76	30400	.041
75	30000	.0375
74	29600	.034
73	29200	.031
72	28800	.029
71	28400	—
70	28000	—
69	27600	—
68	27200	—
67	26800	—
66	26400	—
65	26000	.015
64	25600	—
63	25200	—
62	24800	—
61	24400	—
60	24000	.0105
TTCI → 59	23600	.0100
58	23200	
57	22800	
56	22400	
55	22000	
54	21600	
53	21200	
52	20800	
—	—	—
F 90	36,035	.379
89	35,600	.303
88	35,200	.237
87	34,800	.198
86	34,400	.171
85	34,000	.1335
84	33,600	.111
83	33,200	.094
82	32,800	.081
81	32,400	.069

FATIGUE TEST DATA

SPECIMEN NUMBER: 127 (Bolt-In)

SPECTRUM: F16-400hr(A)

TEST DATE: 11-18-83 //

W 2.00" TH .3005" HOLE DIAM .4415" A .6010 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days (Fast) FM=250

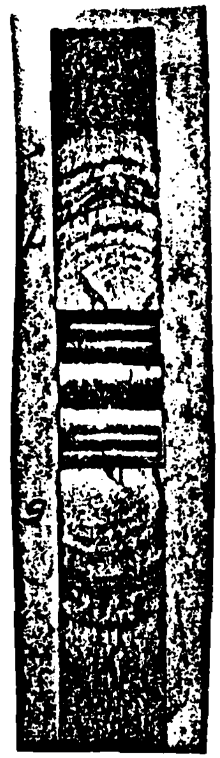
ENVIR. CONDS. Dry Air PREPS. None

CYCLES TO FAILURE 2368865 Kpts % LIFE = 309

TTCI 14,800 FLIGHT HOURS

Larger Flaw = .497"B

Smaller Flaw = .490"B



2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
F 61.8	24748	.497
60	24000	.231
59	23600	.183
58	23200	.153
57	22800	.1245
56	22400	.097
55	22000	.082
54	21600	.070
53	21200	.0605
52	20800	.054
51	20400	.049
50	20000	.0445
49	19600	.041
48	19200	.0365
47	18800	.033
46	18400	.029
45	18000	.027
44	17600	—
43	17200	—
42	16800	—
41	16400	—

FATIGUE TEST DATA

SPECIMEN NUMBER: 127 (cont.)

SPECTRUM: ____________

TEST DATE: ____________ // ____________

W ________ TH ________ HOLE DIAM ________ A ________

MAX STRESS ________ FREQ. ________ 1 LIFE = ________

ENVIR. CONDS. ____________ PREPS. ____________

CYCLES TO FAILURE ____________ % LIFE = ________

TTCI ____________ FLIGHT HOURS

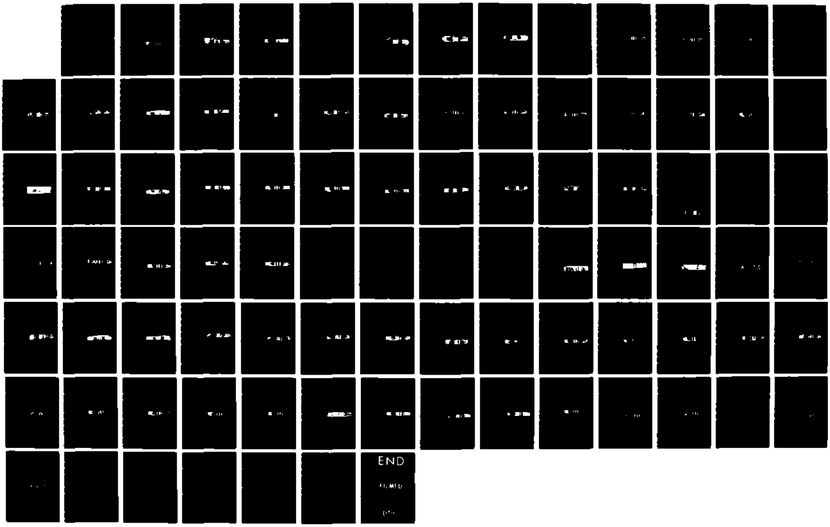
FRACTOGRAPHIC DATA

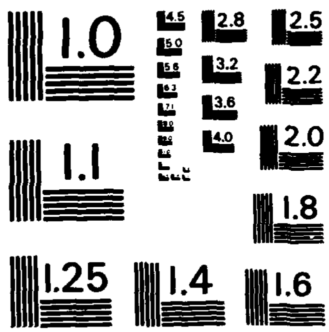
BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0145
39	15600	—
38	15200	—
37	14800	.0100
36	14400	-
35	14000	.0065
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

TTCI

AD-A160 281 DEVELOPMENT OF FATIGUE AND CRACK PROPAGATION DESIGN & ANALYSIS METHODOLOG..(U) GENERAL DYNAMICS FORT WORTH TX FORT WORTH DIV D E GORDON ET AL. AUG 84 3/3

UNCLASSIFIED NADC-83126-60-VOL-4 N62269-81-C-0268 F/G 13/5 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

FATIGUE TEST DATA

SPECIMEN NUMBER: 128 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 11-29-83 //

W 2.0030" TH .3045" HOLE DIAM .4430" A .6099 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast) FH=250

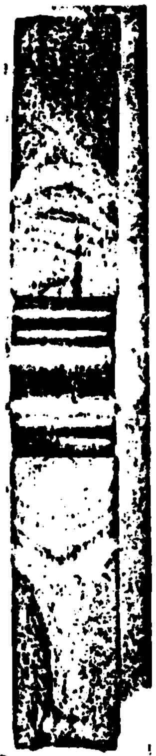
ENVIR. CONDS. Dry PREPS. None

CYCLES TO FAILURE 4100111 ld pts % LIFE = 535

TTCI 35,600 FLIGHT HOURS

LARGER FLAW = .448" (B)

SMALLER FLAW = .411 (B)



L

S

2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
	9		
	8		
F	107	42,835	.448"
	106	42,400	.315
	105	42,000	.243
	104	41,600	.179
	103	41,200	.148
	102	40,800	.124
	101	40,400	.109
	100	40,000	.095
	99	39,600	.079
	98	39,200	.066
	97	38,800	.053
	96	38,400	.042
	95	38,000	.032
	94	37,600	.027
	93	37,200	.023
	92	36,800	.020
	91	36,400	.016
	90	36,000	.0135
TTCI →	89	35,600	.010
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 131 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 12-14-83 //

W 2.0035" TH. .3045" HOLE DIAM .4420" A .6100 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (Slow) FH=40

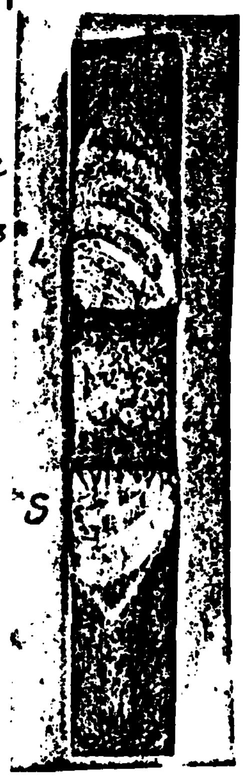
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 134069 ld pts % LIFE = 175

TTCI 8359 FLIGHT HOURS

Larger Flaw = .448" C

Smaller Flaw = .400" B



2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14007 F	.4480
34	13600	.3095
33	13200	.2115
32	12800	.1490
31	12400	.1065
30	12000	.0800
29	11600	.0720
28	11200	.0565
27	10800	.0480
26	10400	.0400
25	10000	.0320
24	9600	.0240
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 132 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 12-16-83 //

W 2.003" TH .3035" HOLE DIAM .4485' A .6079 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16days (Slow) FH=40

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 1956024 Id pts% LIFE = 255

TTCI 9300 FLIGHT HOURS

Larger Flaw = .512"C

Smaller Flaw = .0375"C

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
72	28800	
71	28400	
70	28000	
69	27600	
68	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
61	24400	
60	24000	
59	23600	
58	23200	
57	22800	
56	22400	
55	22000	
54	21600	
53	21200	
52	20800	
51	20435	.512
50	20000	.373
49	19600	.276
48	19200	.189
47	18800	.153
46	18400	.121
45	18000	.098
44	17600	.086
43	17200	.073
42	16800	.062
41	16400	.054

FATIGUE TEST DATA

SPECIMEN NUMBER: 132 (Cont)

SPECTRUM: ____________

TEST DATE: ____________ // ____________

W ________ TH ________ HOLE DIAM ________ A ________

MAX STRESS ________ FREQ. 1 LIFE = ________

ENVIR. CONDS. ____________ PREPS. ____________

CYCLES TO FAILURE ____________ % LIFE = ________

TTCI 9300 FLIGHT HOURS

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	—
39	15600	—
38	15200	—
37	14800	—
36	14400	—
35	14000	—
34	13600	—
33	13200	.026
32	12800	—
31	12400	—
30	12000	.019
29	11600	—
28	11200	—
27	10800	.015
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 140 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 12-1-83 //

W 2.002" TH .3035" HOLE DIAM. _ " A .6076 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast)

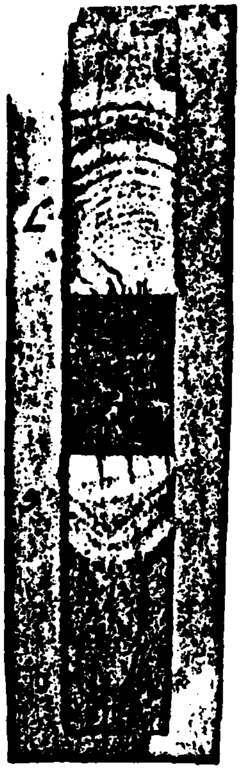
ENVIR. CONDS. Dry Air PREPS. p.c.

CYCLES TO FAILURE 1672744 kpts % LIFE = 218

TTCI 3857 FLIGHT HOURS

Larger Flaw = .5850" B

Smaller Flaw = .300" B


2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.3020
39	15600	.2735
38	15200	.2410
37	14800	.2195
36	14400	.1980
35	14000	.1800
34	13600	.1600
33	13200	.1445
32	12800	.1295
31	12400	.1135
30	12000	.1015
29	11600	.088
28	11200	.0760
27	10800	.0650
26	10400	.0550
25	10000	.0485
24	9600	—
23	9200	—
22	8800	—
21	8400	—
20	8000	.0290
19	7600	—
18	7200	—
17	6800	—
16	6400	—
15	6000	.0175
14	5600	—
13	5200	—
12	4800	—
11	4400	—
TTCI → 10	4000	.0105
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
F 43.6	17440	.5850
42	16800	.3805
41	16400	.3370

FATIGUE TEST DATA

SPECIMEN NUMBER: 141 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 12-05-83 //

W 2.0115" TH .3010" HOLE DIAM .4415" A .6055 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast) FM=250

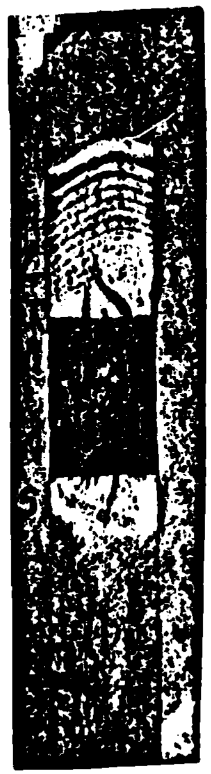
ENVIR. CONDS. Dry Air PREPS. pc

CYCLES TO FAILURE 2106431 ldpts % LIFE = 275

TTCI 9200 √ FLIGHT HOURS

Larger Flaw = .488"

Smaller Flaw = .175"



2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
F55	22000	.488
54	21600	.444
53	21200	.392
52	20800	.356
51	20400	.324
50	20000	.296
49	19600	.267
48	19200	.239
47	18800	.214
46	18400	.191
45	18000	.173
—	—	—
40	16000	.093
—	—	—
35	14000	.060
34	6	.052
33	2	.045
32	8	.037
31	4	.033
30	0	.025
29	6	.022
28	2	.019
—	—	—
TTCI → 23	9200	.010
—	—	—
—	—	—
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 142 (Bolt-In)

SPECTRUM: F16-400hr (A)

TEST DATE: 12-07-83 //

W 2.0035" TH .3010" HOLE DIAM .4415" A .6031 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 2 days (Fast) PH=350

ENVIR. CONDS. Dry Air PREPS. PC

CYCLES TO FAILURE 2336149 ld pts % LIFE = 30.5

TTCI 12,400 FLIGHT HOURS

Larger Flaw = .4715"B

Smaller Flaw = .250"B

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
80	32000	
79	31600	
78	31200	
77	30800	
76	30400	
75	30000	
74	29600	
73	29200	
[illegible]	28800	
[illegible]	28400	
[illegible]	28000	
[illegible]	27600	
[illegible]	27200	
67	26800	
66	26400	
65	26000	
64	25600	
63	25200	
62	24800	
F 61	24400	.4715
60	24000	—
59	23600	.3460
58	23200	.3095
57	22800	.2765
56	22400	.2465
55	22000	.2260
54	21600	.2065
53	21200	.1755
52	20800	.1545
51	20400	.1350
50	20000	.1170
49	19600	.1025
48	19200	.0890
47	18800	.0765
46	18400	—
45	18000	—
44	17600	—
43	17200	—
42	16800	.0365
41	16400	.0300

FATIGUE TEST DATA

SPECIMEN NUMBER: 1A2 (cont.)

SPECTRUM: ____

TEST DATE: ____//____

W ____ TH ____ HOLE DIAM ____ A ____

MAX STRESS ____ FREQ. ____ 1 LIFE = ____

ENVIR. CONDS. ____ PREPS. ____

CYCLES TO FAILURE ____ % LIFE = ____

TTCI ____ FLIGHT HOURS

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0240
39	15600	—
38	15200	—
37	14800	—
36	14400	.0175
35	14000	—
34	13600	—
33	13200	—
32	12800	—
31	12400	.0100
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: 300 Open Hole

SPECTRUM: F-18 300hr

TEST DATE: 2-1-84 //

W 2.0240" TH .3030" HOLE DIAM .4460" A .6133 in²

MAX STRESS 28ksi FREQ. Fast (FM=250)

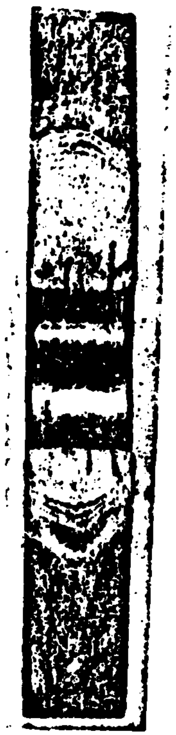
ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 174062 14 pts % LIFE = ——

TTCI 13002 FLIGHT HOURS

LARGER FLAW = .544" B

SMALLER FLAW = .305" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
F 5549	16646	.544
55	16500	.382
54	16200	.2875
53	15900	.184
52	15600	.160
51	15300	.121
50	15000	.089
49	14700	.072
48	14400	.061
47	14100	.046
46	13800	.0345
45	13500	.023
44	13200	.0135
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 301 Open Hole

SPECTRUM: F-18 300hr

TEST DATE: 2-1-84 //

W 2.0030" TH .3038" HOLE DIAM .4470" A .6085 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

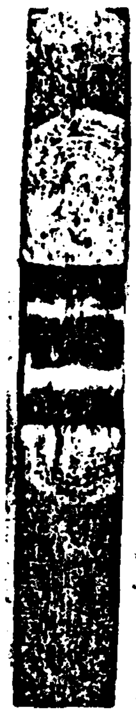
ENVIR. CONDS. 3.5% Nacl PREPS. ——

CYCLES TO FAILURE 127070 ld pts % LIFE ——

TTCI 9077 FLIGHT HOURS

LARGER FLAW = .438" B

SMALLER FLAW = .301" B



L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	12000	.372"
39	11700	.261
38	11400	.1890
37	11100	.1355
36	10800	.094
35	10500	.064
34	10200	.0475
33	9900	.0355
32	9600	.025
TTCI → 31	9300	.015
30	9000	.0085
29		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
F 40.51	12152.1	.438
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 302 Open Hole

SPECTRUM: F18-300hr (B)

TEST DATE: 2-2-84 //

W 2.001" TH .3030" HOLE DIAM .4450" A .6063 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

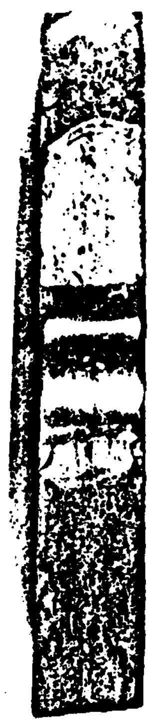
ENVIR. CONDS. 3.5% NaCl PREPS. None

CYCLES TO FAILURE 122725 ld pts

TTCI 8267 FLIGHT HOURS

LARGER FLAW = .4690" (B)

SMALLER FLAW = .1175" (B)



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
F	39.12	11737	.4690
	38	11400	.3750
	37	11100	.270
	36	10800	.2020
	35	10500	.170
	34	10200	.1225
	33	9900	.0865
	32	9600	.066
	31	9300	.0495
	30	9000	.040
	29	8700	.024
TTCI	28	8400	.014
	27	8100	.005
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 303 Open hole

SPECTRUM: F18 300hr

TEST DATE: 2-2-84 //

W 2.003" TH .302" HOLE DIAM .4415" A .6049 in²

MAX STRESS 28 KSI FREQ. FAST (FM=250)

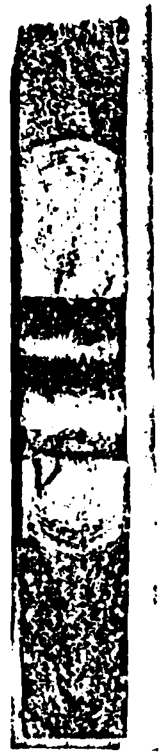
ENVIR. CONDS. 3.5% NaCl PREPS. ——

CYCLES TO FAILURE 224317 kpts % LIFE ——

TTCI 17323 FLIGHT HOURS

LARGER FLAW = .437" B

SMALLER FLAW = .256" B



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FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
F	71.51	21452	.437
	71	21300	.360
	70	21000	.278
	69	20700	.204
	68	20400	.156
	67	20100	.130
	66	19800	.112
	65	19500	.095
	64	19200	.080
	63	18900	.065
	62	18600	.048
	61	18300	.040
	60	18000	.028
	59	17700	.017
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 304 Open hole

SPECTRUM: F18 300hr

TEST DATE: 2-1-84 //

W 2.0" TH .3025" HOLE DIAM .4400" A .6050 in²

MAX STRESS 28 ksi FREQ. Fast (FM: 250)

ENVIR. CONDS. 3.5% Nacl PREPS. pc

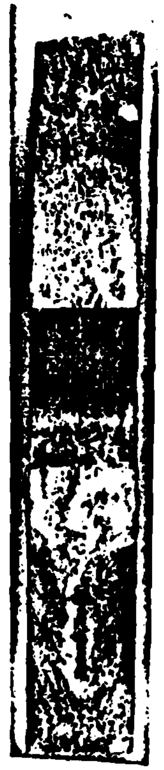
CYCLES TO FAILURE 112055 Lpts % LIFE —

TTCI 7310 FLIGHT HOURS

LARGER FLAW = .4195" B

SMALLER FLAW = .2522" B

L



S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
F 35.72	10716.2	.4195
35	10500	.2925
34	10200	.2275
33	9900	.1805
32	9600	.1370
31	9300	.1025
30	9000	.0855
29	8700	.0530
28	8400	.0430
27	8100	.0310
26	7800	.0220
25	7500	.0130
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 305 Open hole

SPECTRUM: F18 300hr (B)

TEST DATE: 2-1-84 //

W 2.0045" TH. .3010" HOLE DIAM .4405" A .6034 in²

MAX STRESS 28ksi FREQ. Fast (FM=250)

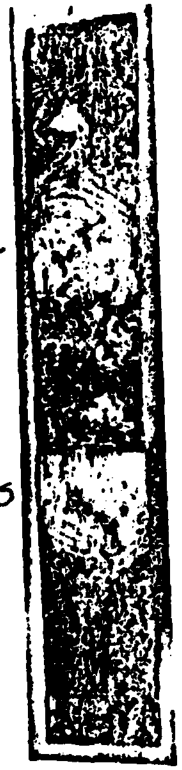
ENVIR. CONDS. 3.5% NaCl PREPS. PC

CYCLES TO FAILURE 85356 % LIFE = ——

TTCI 5548 FLIGHT HOURS

LARGER FLAW = .358" B

SMALLER FLAW = .353" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
F 27,21	8163	.358
27	8100	.303
26	7800	.184
25	7500	.117
24	7200	.093
23	6900	.072
22	6600	.049
21	6300	.035
20	6000	.022
19	5700	.013
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 306 Open hole

SPECTRUM: F18 300hr

TEST DATE: 2-2-84 //

W 2.003" TH .3045' HOLE DIAM .4410' A .6099 in²

MAX STRESS 28 ksi FREQ. Fast (CFM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 61862 ld pts % LIFE = ——

TTCI 3141 FLIGHT HOURS

LARGER FLAW = .4010" B

SMALLER FLAW = .2510" B

L

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FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F	19.72	3916	.4010
	19	3700	.3060
	18	3400	.2385
	17	5100	.1870
	16	4800	.1400
	15	4500	.0950
	14	4200	.0735
	13	3900	.055
	12	3600	.0355
	11	3300	.0140
	0		
	9		
	8		
	7		
	5		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 307 Open Hole

SPECTRUM: F18 300hr(B)

TEST DATE: 2-2-84 //

W 2.002" TH .302" HOLE DIAM .4435" A .6046 in²

MAX STRESS 28 ksi FREQ. Fast (FM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 99943 ld pts % LIFE —

TTCI 6161 FLIGHT HOURS

LARGER FLAW = .433" B

SMALLER FLAW = .274" B

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
F 31.86	9557.8	.433
31	9300	.310
30	9000	.239
29	8700	.1965
28	8400	.148
27	8100	.1685
25	7800	.0655
25	7500	.0475
24	7200	.0340
23	6900	.0230
22	6600	.0180
21	6300	.0115
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 312 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-2-84 //

W 2.0040" TH .2900" HOLE DIAM .4415" A .5841 in²

MAX STRESS 28 Ksi FREQ. Fast (FM=250)

ENVIR. CONDS. Dry PREPS. pc

CYCLES TO FAILURE 164102 ld pts % LIFE = —

TTCI 9650 FLIGHT HOURS

LARGER FLAW = .378" (B)

SMALLER FLAW = .299" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
F 52.31	15693	.378
52	15600	.335
51	15300	.267
50	15000	.215
49	14700	.191
48	14400	.175
47	14100	.155
46	13800	.133
45	13500	.119
44	13200	.106
43	12900	.096
42	12600	.085
41	12300	.077
40	12000	.064
39	11700	.051
38	11400	.044
37	11100	.034
36	10800	.028
35	10500	.024
34	10200	.020
33	9900	.015
TTCI → 32	9600	.009
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 313 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-3-84 11

W 2.0030" TH .3070" HOLE DIAM .4455" A .6149 in²

MAX STRESS 28 Ksi FREQ. Fast (FM=250)

ENVIR. CONDS. Dry PREPS. PC

CYCLES TO FAILURE 155972 ldpts % LIFE = —

TTCI 7176 FLIGHT HOURS

LARGER FLAW = .416" (B)

SMALLER FLAW = .292" (B)


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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F 49.72	14916	.416
49	14700	.340
48	14400	.280
47	14100	.239
46	13800	.204
45	13500	.178
44	13200	.150
43	12900	.137
42	12600	.122
41	12300	.108
40	12000	.097
39	11700	.090
38	11400	.079
37	11100	.073
36	10800	.060
35	10500	.052
34	10200	.044
33	9900	.039
32	9600	.033
31	9300	.030
30		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 314 Open Hole

SPECTRUM: F18-300hr.

TEST DATE: 2-3-84 //

W 2.0065" TH .3030" HOLE DIAM .4435' A .6079 in²

MAX STRESS 28 ksi FREQ. (Fast FM=250)

ENVIR. CONDS. Dry PREPS. pc

CYCLES TO FAILURE 120172 ldpts % LIFE = —

TTCI 4733 FLIGHT HOURS

LARGER FLAW = .420" (B)

SMALLER FLAW = .240' (B)

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
38.31	11493	.420
38	11400	.375
37	11100	.311
36	10800	.268
35	10500	.237
34	10200	.212
33	9900	.198
32	9600	.188
31	9300	.162
30	9000	.150
29	8700	.136
28	8400	.125
27	8100	.114
26	7800	.095
25	7500	.083
24	7200	.070
23	6900	.058
22	6600	.047
21	6300	.040
20	6000	.033
19	5700	.024
18	5400	.020
17	5100	.016
TTCI → 16	4800	.011
15	4500	.0065
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

F

FATIGUE TEST DATA

SPECIMEN NUMBER: 315 Open Hole F

SPECTRUM: F18-300hr

TEST DATE: 2-6-84 //

W 2.0015" TH .2960" HOLE DIAM .4435" A .5924 in²

MAX STRESS 28ksi FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. No

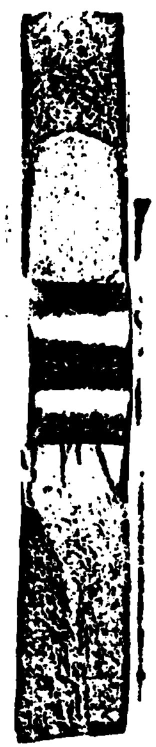
CYCLES TO FAILURE 218044 ldpts % LIFE = ——

TTCI 15752 FLIGHT HOURS

LARGER FLAW = .410" (B)

SMALLER FLAW = .232" (B)

L



S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
69.51	20853.	.410
69	20700	.354
68	20400	.299
67	20100	.265
66	19800	.235
65	19500	.202
64	19200	.181
63	18900	.157
62	18600	.139
61	18300	.122
60	18000	.105
59	17700	.088
58	17400	.073
57	17100	.060
55	16800	.045
55	16500	.032
54	16200	.021
53	15900	.0125
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 316 Open Hole

SPECTRUM: F18- 300hr

TEST DATE: 2-6-84 11

W 2.0035' TH .3010" HOLE DIAM .4405" A .6031 in^2

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 278098 ldpts % LIFE = —

TTCI 22608 FLIGHT HOURS

LARGER FLAW = .472" (B)

SMALLER FLAW = .370" (B)

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
F 88.65	26,595	.472
88	26,400	.340
87	26,100	.267
86	25800	.216
85	25,500	.173
84	25200	.145
83	24900	.120
82	24600	.097
81	24300	.068
80	24000	.049
79	23700	.035
78		
77		
76		
75		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 317 Open hole

SPECTRUM: F18 300hr

TEST DATE: 2-6-84 //

W 2.0015" TH .2990" HOLE DIAM .4435" A .5985 in²

MAX STRESS 28 ksi FREQ. Fast FM=250

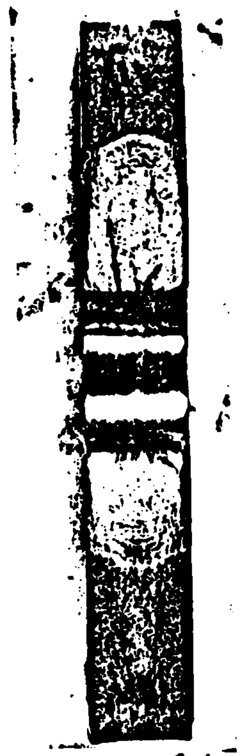
ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 261961 ldpts % LIFE = —

TTCI 10324 FLIGHT HOURS

LARGER FLAW = .430" B

SMALLER FLAW = .324" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
83.51	25053	.430
83	24900	.359
82	24600	.295
81	24300	.265
80	24000	.242
79	23700	.221
78	23400	.207
77	23100	.192
76	22800	.187
75	22500	.167
74	22200	.152
73	21900	.134
72	21600	.119
71	21300	.109
70	21000	.097
69	20700	.081
68	20400	.073
67	20100	.065
66	19800	.059
65	19500	.053
64	19200	.048
63	18900	.046
62	18600	.044
61	18300	.042
60	18000	.040
59	17700	.038
—	—	—
49	14700	.023
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 318 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-6-84 11

W 2.0010" TH .3020" HOLE DIAM .4415" A .6043in²

MAX STRESS 28 KSI FREQ. Slow (Freq. Multiplier = 40)

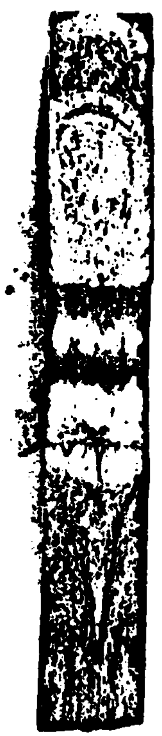
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 153460 ld pts % LIFE = —

TTCI 12038 FLIGHT HOURS

LARGER FLAW = .554" (B)

SMALLER FLAW = .121" (B)



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F	48.92	14676	.554
	48	14400	.413
	47	14100	.315
	46	13800	.239
	45	13500	.154
	44	13200	.109
	43	12900	.080
	42	12600	.036
	41	12300	.017
TTCI	40	12000	.009
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 319 Open Hole

SPECTRUM: F18-300 hr

TEST DATE: 2-7-84 //

W 2.0010" TH .3050" HOLE DIAM .4445" A .6103 in²

MAX STRESS 28 KSI FREQ. Slow (FM=40)

ENVIR. CONDS. 3.5% NaCl PREPS. No

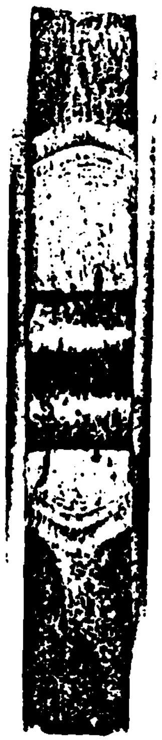
CYCLES TO FAILURE 111973 ld pts % LIFE ± —

TTCI 6517 FLIGHT HOURS

LARGER FLAW = .4830" (B)

SMALLER FLAW = .2875" (B)

L



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2X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
	9		
	8		
	7		
F	35.69	10,707	.4830
	35	10,500	.3465
	34	10,200	.2455
	33	9900	.1855
	32	9600	.1620
	31	9300	.1395
	30	9000	.1105
	29	8700	.0885
	28	8400	.0720
	27	8100	.0585
	26	7800	.0455
	25	7500	.0365
	24	7200	.0285
	23	6900	—
TTCI	22	6600	.0125
	21	6300	.0045
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 320 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-7-84 //

W 1.9985" TH .3020" HOLE DIAM .4425" A .6035 in²

MAX STRESS 28KSI FREQ. Slow (FM=40)

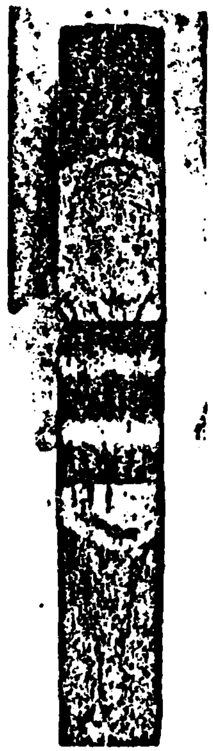
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 124602 ldpts % LIFE

TTCI 8447 FLIGHT HOURS

LARGER FLAW = (.487")(B)

SMALLER FLAW = .183" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F 39.72	11916	.487"
39	11700	.362
38	11400	.277
37	11100	.205
36	10800	.158
35	10500	.126
34	10200	.086
33	9900	.072
32	9600	.055
31	9300	.044
30	9000	.028
TTCI → 29	8700	.018
28	8400	.0085
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 321 Open Hole

SPECTRUM: F18- 300hr

TEST DATE: 2-7-84 11

W 1.9995" TH .2980" HOLE DIAM .4435" A .5959in²-F

MAX STRESS 28 Ksi FREQ. Slow (FM=40)

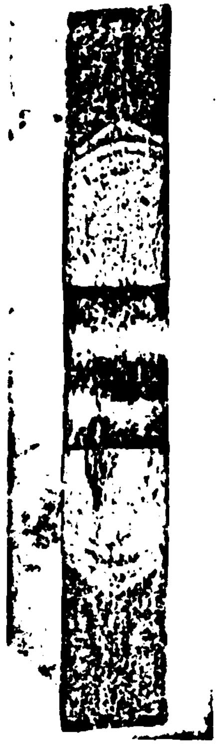
ENVIR. CONDS 3.5% NaCl PREPS. No

FAILURE 104322 ldpts % LIFE = —

FLIGHT HOURS

LARGER FLAW .4555" B

SMALLER FLAW .3935" B



L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
33.25	9975	.4555"
33	9900	.295"
32	9600	.214
31	9300	.123
30	9000	.078
29	8700	.0810
28	8400	.053
27	8100	.033
26	7800	.020
25	7500	.0165
24	7200	.011
MCI → 23	6900	.006
—	—	—
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 322 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-3-84 11

W 2.0045" TH .3030" HOLE DIAM .4405" A .6074 in²

MAX STRESS 28 Ksi FREQ. Slow (FM=40) TTCI

ENVIR. CONDS. 3.5% Nacl PREPS. pc

CYCLES TO FAILURE 87395 ldpts % LIFE ∗ —

TTCI 6076 FLIGHT HOURS

LARGER FLAW = .358" B

SMALLER FLAW = .3495" B

1.72X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
	—	—
F 27.86	8358	.358
27	8100	.219
26	7800	.153
25	7500	.122
24	7200	.084
23	6900	.063
22	6600	.024
21	6300	.0135
20	6000	.009
—	—	—
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 323(b) Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-24-84 //

W 2.0000" TH .3020" HOLE DIAM .4415" A .6040 in²

MAX STRESS 28 KSI FREQ. Slow (FM = 40) F

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 98837 ld pts.

TTCI 6097 FLIGHT HOURS

LARGER FLAW = .4725" (C)

SMALLER FLAW = .2835" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
31.51	9453	.4725
31	9300	.3715
30	9000	.2860
29	8700	.2415
28	8400	.1965
27	8100	.1635
26	7800	.1005
25	7500	.080
24	7200	.061
23	6900	.040
22	6600	.0235
21		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 324 Open Hole

SPECTRUM: F18-300hr (B)

TEST DATE: 2-20-84 11

W 2.0000" TH .3035" HOLE DIAM .4425" A .6070 10^{-4}F

MAX STRESS 28KSI FREQ. Slow (FM=40)

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 261100 ld pts

TTCI 21,772 FLIGHT HOURS

LARGER FLAW = .4255" (B)

SMALLER FLAW = .3770" (B)

TTCI → 73

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
83.23	24969	.4255
83	24900	.3395
82	24600	.2095
81	24300	.1490
80	24000	.1120
79	23700	.0855
78	23400	.0590
77	23100	.0510
76	22800	.0390
75	22500	.0310
74	22200	.023
73	21900	.013
72	21600	.0065
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 325 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-14-84 11

W 2.0010" TH .3015" HOLE DIAM .4425" A .6033 in²

MAX STRESS 28 KSI FREQ. Slow (FM = 40)

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 82219 1d pts

TTCI 5368 FLIGHT HOURS

LARGER FLAW = .4335" (B)

SMALLER FLAW = .289" (B)

L

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
F 26.21	7863	.4335
26	7800	.378
25	7500	.242
24	7200	.172
23	6900	.1345
22	6600	.091
21	6300	.0605
20	6000	.036
19	5700	.0195
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 326 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-13-84 11

W 2.0010" TH .3010" HOLE DIAM .4425" A .6023"

MAX STRESS 28KSI FREQ. Slow (FM = 40)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 237534 ld pts

TTCI 20143 FLIGHT HOURS

LARGER FLAW = .349" B

SMALLER FLAW = .294" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
	—	—
F 75.72	22716	.349
72	22500	.271
4	22200	.189
3	21900	.152
2	21600	.103
1	21300	.077
0	21000	.054
9	20700	.029
TTCI 8	20400	.016
7	20100	.009
	—	—
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

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2X

FATIGUE TEST DATA

SPECIMEN NUMBER: 327

SPECTRUM: F18-300hr

TEST DATE: 2-13-84 //

W 2.0015" TH .3010" HOLE DIAM .4415" A .6025"

MAX STRESS 28KSI FREQ. Slow (FM=40)

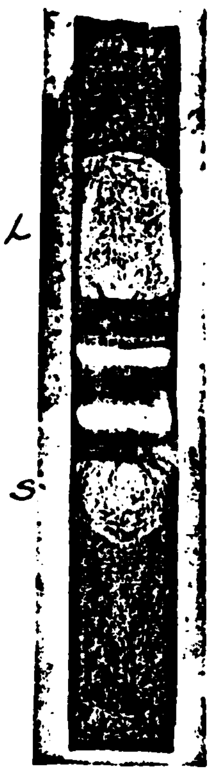
ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 256356 ldpts

TTCI 21824 FLIGHT HOURS

LARGER FLAW = .406"B

SMALLER FLAW = .234"B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
	—	—
F 81.72	24516	.406
81	24300	.337
0	24000	.274
9	23700	.230
8	23400	.165
7	23100	.134
6	22800	.073
5	22500	.046
4	22200	.031
TTCI → 3	21900	.0120
2	21600	.005
	—	—
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 328 Open Hole

SPECTRUM: F18-300hr

TEST DATE: 2-13-84 //

W 2.0000' TH .3025' HOLE DIAM .4415' A .6050'

MAX STRESS 28KSI FREQ Slow (FM=40)

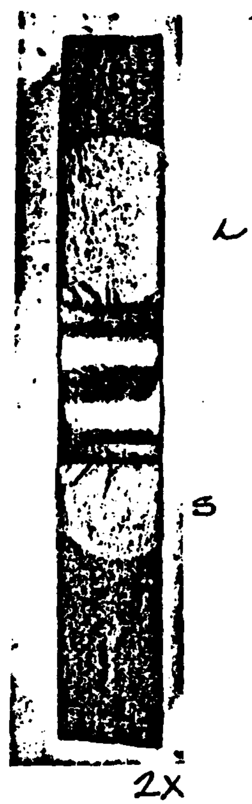
ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 234721 ld.pts.

TTCI 19800 FLIGHT HOURS

LARGER FLAW = .463" B

SMALLER FLAW = .265" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
	—	—
F 74.82	22446	.463
74	22200	.379
3	21900	.317
2	21600	.235
1	21300	.181
0	21000	.140
9	20700	.085
8	20400	.046
7	20100	.028
TTCI → 6	19800	.010
	—	—
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 329 Open Hole

SPECTRUM: F18-300hr(B)

TEST DATE: 2-21-84 11

W 2.0005" TH .3015" HOLE DIAM .4465" A .6032 in² F

MAX STRESS 28 KSI FREQ. Slow (FM = 40)

ENVIR. CONDS. Dry PREPS. pc

CYCLES TO FAILURE 168520 ld pts

TTCI 12,797 FLIGHT HOURS

LARGER FLAW = .4125" (B)

SMALLER FLAW = .3545" (B)

FRACTOGRAPHIC DATA

TTCI → 42

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
53.72	16116	.4125
53	15900	.2915
52	15600	.231
51	15300	.199
50	15000	.169
49	14700	.142
48	14400	.114
47	14100	.076
45	13800	.0545
45	13500	.0340
44	13200	.020
43	12900	.0120
42	12600	
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 330

SPECTRUM: F18-300hr (B)

TEST DATE: 2-17-84 11

W 1.9990" TH .2950" HOLE DIAM .4470" A .5897

MAX STRESS 28 KSI FREQ Slow (FM=40)

ENVIR. CONDS. Dry PREPS. pc

CYCLES TO FAILURE 196084 ld pts

TTCI 15650 FLIGHT HOURS

LARGER FLAW = .3715" (B)

SMALLER FLAW = .355" (B)

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2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
F 62.51	18753	.3715
62	18600	.320
61	18300	.264
60	18000	.225
59	17700	.169
58	17400	.127
57	17100	.074
56	16800	.055
55	16500	.035
54	16200	.024
TTCI 53	15900	.015
52	15600	.009
50	15000	
49	14700	
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 331

SPECTRUM: F18-300hr (B)

TEST DATE: 2-14-84 11

W 1.9990" TH .2990" HOLE DIAM .4430" A .5977"

MAX STRESS 28KSI FREQ. Slow (FM = 40)

ENVIR. CONDS. Dry PREPS. pc

CYCLES TO FAILURE 164101 ld pts

TTCI 12175 FLIGHT HOURS

LARGER FLAW = .4325" (B)

SMALLER FLAW = .3050" (B)

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
F 5231	15693	.4325
52	15600	.3890
51	15300	.3170
50	15000	.250
49	14700	.2095
48	14400	.1625
47	14100	.1325
46	13800	.0825
45	13500	.0665
44	13200	.0440
43	12900	.0280
42	12600	.0180
41	12300	.0120
—	—	—
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 336 Open Hole

SPECTRUM: F16-400hr (A)

TEST DATE: 3-1-84 //

W 2.0040" TH .3010" HOLE DIAM .4415" A .6032"

MAX STRESS 28KSI FREQ. 1 LIFE = 16days (Slow = 40)

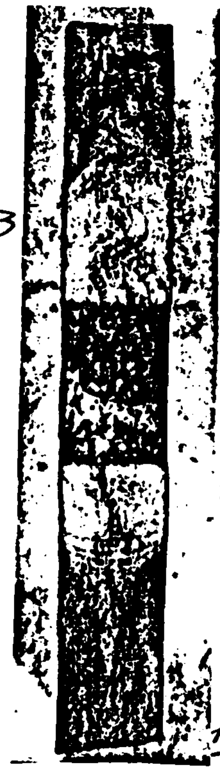
ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 306 908 ld pts % LIFE = 40

TTCI 851 FLIGHT HOURS

Larger Flaw = .440" B

Smaller Flaw = .288" B



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	.440
7	2800	.154
6	2400	.099
5	2000	.056
4	1600	.034
3	1200	.018
2	800	.009
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 337 Open Hole

SPECTRUM: F16-400hr (A)

TEST DATE: 3-9-84 11

W 2.0010" TH .3005" HOLE DIAM .4415" A .6013"

MAX STRESS 28KSI FREQ. 1 LIFE = 16days (Slow FM=10)

ENVIR. CONDS. 3.5% NaCl PREPS. pc

CYCLES TO FAILURE 551385 ld pts % LIFE ≐ 72

TTCI 4456 FLIGHT HOURS

Larger Flaw = .5625" (B)

Smaller Flaw = .086" (B)

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	19	7600	
	18	7200	
	17	6800	
	16	6400	
F	14.47	5792	.5625
	14	5600	.3480
	13	5200	.1380
	12	4800	.13
	11	4400	.0770
	10	4000	.0455
	9	3600	.0335
	8	3200	.0245
	7	2800	.0195
TTCI	6	2400	.0150
	5	2000	.009
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 338 20% LT

SPECTRUM: F16-400hr(A)

TEST DATE: 3-15-84 //

W 1.9990" TH .2950" HOLE DIAM .4425" A .5897"

MAX STRESS 28KSI FREQ. 1 LIFE = 16days (Slow FM=40)

ENVIR. CONDS. 3.5% NaCl PREPS. DC

CYCLES TO FAILURE 378903 ldpts % LIFE = 49

TTCI 2000 FLIGHT HOURS

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Larger Flaw - .544" B

Smaller Flaw - .377" C

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
F 9.8	39[illegible]	.544
9	3600	.192
8	3200	.082
7	2800	.041
6	2400	.022
TTCI 5	2000	.010
4	1600	.006
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 515 Open Hole

SPECTRUM: F18 BLOCK

TEST DATE: 5-10-84 //

W 1.9955" TH .3050" HOLE DIAM .5030" A .6086"

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. No

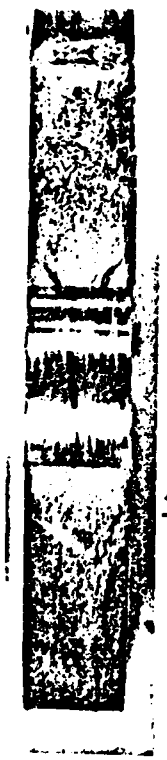
CYCLES TO FAILURE 523879 ld. pts.

TTCI 27,709 FLIGHT HOURS

LARGER FLAW = .388" (B)

SMALLER FLAW = .242" (B)

L



S

2X

TTCI →

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
F 167	50100	.388
166	48800	.346
165	48500	.298
164	48200	.277
163	47900	.252
162	47600	.239
161	47300	.223
160	47000	.208
—	—	—
150	45000	.108
—	—	—
140	42000	.066
—	—	—
130	39000	.045
—	—	—
120	36000	.030
—	—	—
110	33000	.019
—	—	—
100	30000	.0135
—	—	—
90	27000	.0090
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 516 Open Hole

SPECTRUM: F18 Block

TEST DATE: 5-16-84 11

W 2.0050" TH .2955" HOLE DIAM .5065" A .5924"

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 330,397 ld pts

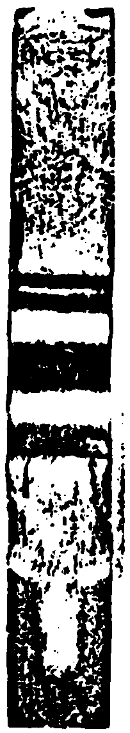
TTCI 10,789 FLIGHT HOURS

LARGER FLAW = .408" (B)

SMALLER FLAW = .278" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
F 105.32	31,596	.408"
104	31200	.308
103	30900	.270
102	30600	.245
101	30300	.224
100	30000	.210
99	29700	.192
98	29400	.179
—	—	—
88	26400	.085
—	—	—
78	23400	.049
—	—	—
68	20400	.031
—	—	—
58	17400	.021
—	—	—
48	14400	.017
—	—	—
38	11400	.011
—	—	—
28	8400	.0065
9		
8		
7		
6		
5		
4		
3		
2		
1		



FATIGUE TEST DATA

SPECIMEN NUMBER: 517 Open Hole

SPECTRUM: F18 BLOCK

TEST DATE: 5-16-84 11

W 1.9935" TH .2970" HOLE DIAM .5050" A .5920"

MAX STRESS 28KSI FREQ. Fast (FM=250)

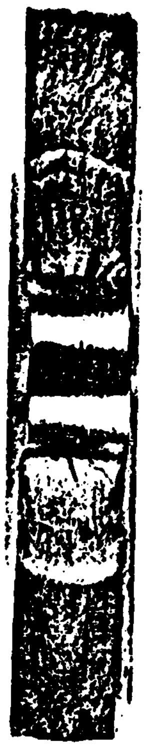
ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 678804 ld pts

TTCI 40500 FLIGHT HOURS

LARGER FLAW = .648" (B)

SMALLER FLAW = .344" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
F 216 37	64916	.648
215	64500	.390
214	64200	.329
213	63900	.291
212	63600	.265
211	63300	.248
210	63000	.234
209	62700	.221
208	62400	.208
207	62100	.198
206	61800	.189
—	—	—
205	61500	.174
204	61200	.158
203	60900	.147
202	60600	.135
201	60300	.126
200	60000	—
—	—	—
190	57000	.079
—	—	—
180	54000	.050
—	—	—
170	51000	.032
—	—	—
160	48000	.023
—	—	—
150	45000	.016
—	—	—
140	42000	.012
—	—	—
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 518 Open Hole

SPECTRUM: F18 BLOCK

TEST DATE: 5-17-84 11

W 1.9955" TH .2960" HOLE DIAM .5030" A .5906"

MAX STRESS 28 KSI FREQ. Fast (FM=250)

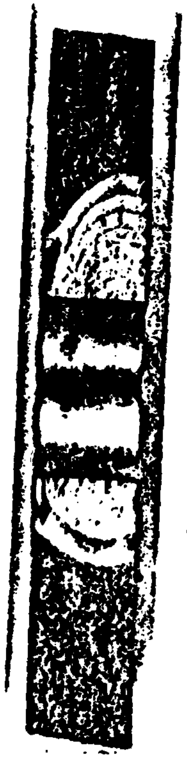
ENVIR. CONDS. 3.5 % Nacl PREPS. No

CYCLES TO FAILURE 213317 ld pts.

TTCI 15,300 FLIGHT HOURS

LARGER FLAW = .355" (B)

SMALLER FLAW = .240" (B)



FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
	9		
F	68	20400	.355
	67	20100	.321
	66	19800	.256
	65	19500	.210
	64	19200	.167
	63	18900	.125
	62	18600	.095
	61	18300	.068
	60	18000	.048
	59	17700	.041
	58	17400	.035
	57	17100	.030
	55	16800	.027
	55	16500	.022
	54	16200	.018
	53	15900	.014
	52	15600	.012
TTCI →	51	15,300	.010
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 519 Open Hole

SPECTRUM: F18 BLOCK

TEST DATE: 5-18-84 11

W 2.0020" TH .2945' HOLE DIAM .5030" A .5895' F

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

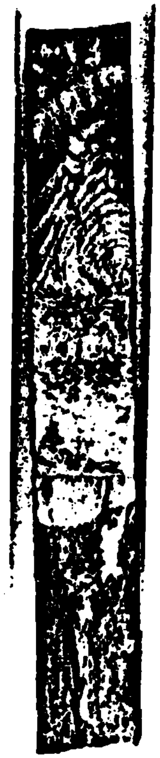
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 203905 ld pts.

TTCI 4500 FLIGHT HOURS

LARGER FLAW = .627" (C)

SMALLER FLAW = .134' (B)



L

S

TTCI

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
65	19500	.627
64	19200	.541
63	18900	.452
62	18600	.405
61	18300	.368
60	18000	.332
59	17700	.294
58	17400	.259
57	17100	.229
56	16800	.199
55	16500	.175
54	16200	.151
53	15900	.134
52	15600	.118
51	15300	.106
50	15000	.095
49	14700	.087
—	—	—
40	12000	.035
—	—	—
30	9000	.013
—	—	—
15	4500	.010
—	—	—
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 520 Open Hole

SPECTRUM: F18 BLOCK

TEST DATE: 5-18-84 11

W 2.0045" TH .3010" HOLE DIAM .5050" A .6033" F

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 200768 ld pts

TTCI 11,100 FLIGHT HOURS

LARGER FLAW = .380" (B)

SMALLER FLAW = .241" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
64	19200	.380
63	18900	.341
62	18600	.237
61	18300	.178
60	18000	.121
59	17700	.097
58	17400	.080
57	17100	.067
56	16800	.058
55	16500	.051
54	16200	.046
53	15900	.042
52	15600	.039
51	15300	.036
50	15000	.033
—	—	—
45	13500	.021
—	—	—
40	12000	.014
—	—	—
37	11100	.010
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

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APPENDIX F

SPECTRUM FATIGUE TEST RESULTS AND FRACTOGRAPHIC DATA FOR TASK 6 (7075-T7651 ALUMINUM ALLOY

Spectrum fatigue test results for the dog-bone specimens (Fig. 3) tested under Task 6 are summarized in Table F1. Fractographic data sheets are also presented in this appendix.

The maximum positive load in each load spectra, including overloads, was considered to be the 100% load level. The maximum positive test load for each spectra was selected to produce the desired gross stress on the specimen cross section. All other loads positive and negative in each respective test spectra were "scaled" to the 100% load level. As a result, "overloads" in the F-18 300 hour spectrum were treated as 100% load levels rather than a percentage greater than the 100% load level.

Fatigue loading frequencies for all spectrum tests, including the F-18 300 hour spectrum, were based on the test rates set for the F-16 400 hour spectrum tests. Loading rates were selected to complete 8000 equivalent flight hours of the F-16 400 hour spectrum in a selected number of days (24 hours a day continuous testing). Three basic loading frequencies were considered: (1) F = fast (8000 flight hours/2 days), (2) S = slow (8000 flight hours/16 days) and (3) XS = extra slow (8000 flight hours/90 days). Accordingly, test machine frequency multipliers (FM) were set for the three basic frequencies: Fast (FM = 250), slow (FM = 40) and extra slow (FM = 1). The frequency multipliers can only be translated into actual frequency measurements for constant amplitude loading.

Table F1 Summary of Dog-Bone Specimen Fatigue Test Results for Task 6 (7075-T7651 Aluminum)

SPECIMEN NO.	TEST I.D. (a)	DATA SET NO.	TEST DATE	SPECIMEN DETAILS WIDTH (IN)	THICK (IN)	HOLE DIA (IN.)	GROSS AREA (IN^2)	FATIGUE CRACK ORIGIN (b)	TTCI (FLT. HRS.) (c)	TTF (FLT. HRS.) (d)	TTF-TTCI (FLT. HRS.) (e)	TTCI / TTF
66	A-28/20/F/W	16	6-20-83	2.0	.2975	.4444	.5950	B	3400	8904	5504	.38
68	A-28/20/F/W	16	7-6-83	2.0139	.3079	(h) -	.6201	B	4508	7600	3092	.59
69	A-28/20/S/W	18	7-11-83	2.0800	.3040	.4450	.6323	B	1662	5607	3945	.29
70	A-28/20/S/W	18	7-11-83	2.0065	.3040	.447	.6099	B	3665	7068	3403	.52
73	A-28/20/S/D	17	7-20-83	2.0450	.3040	.4455	.6217	B	14100	24800	10700	.57
74	A-28/20/F/D	15	7-21-83	2.0350	.3030	.446	.6166	B	8800	18000	9200	.49
75	A-28/20/F/D	15	8-1-83	2.010	.3025	.4405	.6080	B	10203	20000	9797	.51
80	A-28/20/F/D	15	8-9-83	1.9995	.3035	.4410	.6068	B	16800	28000	11200	.600
308	B-28/20/F/D	30	2-6-84	2.0010	.3030	.4405	.6063	B	7228	11163	3935	.65
309	B-28/20/F/D	30	2-7-84	2.0035	.3010	.4415	.6031	B	8100	12037	3937	.67
310	B-28/20/F/D	30	2-8-84	1.9990	.3020	.4435	.6037	B	17115	21037	3922	.81
311	B-28/20/F/D	30	2-9-84	1.9995	.3020	.4435	.6039	B	8764	11916	3152	.74
332	B-28/20/F/W	29	2-17-84	2.0000	.3010	.4465	.6020	B	6343	11358	5015	.56
333	B-28/20/F/W	29	2-20-84	2.0005	.3030	.4415	.6062	B	11311(f)	14253	2942	.79
334	B-28/20/F/W	29	2-21-84	2.0000	.3020	.4430	.6040	B	6712	9258	2546	.72
335	B-28/20/F/W	29	2-23-84	2.0020	.3015	.4435	.6036	B	7799(f)	9858	2059	.79
500	B-28/40/F/D	31	5-2-84	2.0025	.3065	.4455	.6138	B	16800	19653	2853	.85
501	B-28/40/F/D	31	5-3-84	1.9995	.3020	.4460	.6039	B	21522	25236	3714	.85
502	B-28/40/F/D	31	5-3-84	2.0000	.3035	.4445	.6070	B	16064	19716	3652	.81
503	B-28/40/F/W	32	5-7-84	2.0010	.3020	.4435	.6043	B	6633	8916	2283	.74
504	B-28/40/F/W	32	5-7-84	2.0010	.3030	.4440	.6063	B	8218	11446	3228	.72
505	B-28/40/F/W	32	5-9-84	2.0000	.3030	.4435	.6060	B	5127	7836	2709	.65
506	A-28/40/F/D	19	4-16-84	2.0025	.3020	.4450	.6148	B	11736	24835	13099	.47
507	A-28/40/F/D	19	4-17-84	2.0030	.3020	.4450	.6049	B	16000	30006	14006	.53
508	A-28/40/F/D	19	4-23-84	2.0015	.3030	.4440	.6065	B	22218	36006	13788	.62
509	A-28/40/F/W	20	4-23-84	2.0010	.3015	.4450	.6033	B	6048	11206	5158	.54
510	A-28/40/F/W	20	4-25-84	2.0030	.3030	.4455	.6069	B	5149	8400	3251	.61
511	A-28/40/F/W	20	4-27-84	2.0015	.3000	.4455	.6005	B	6821	9635	2814	.71
521	C-28/40/F/D	35	5-10-84	2.0030	.3015	.4455	.6039	B	9591(f)	30600	21009	.31
522	C-28/40/F/D	35	5-10-84	2.0010	.3015	.4470	.6033	B	16200	33300	17100	.49
523	C-28/40/F/D	35	5-14-84	2.0020	.3020	.4465	.6046	B	21278	40200	18922	.53
524	C-28/F/W	36	5-14-84	2.0000	.2995	.5030	.5990	B	6900	13500	6600	.51
525	C-28/F/W	36	5-16-84	1.9965	.3005	.5030	.5999	B	6600	13800	7200	.48
526	C-28/F/W	36	5-17-84	2.0025	.3005	.5045	.6017	B	955(g)	9900	8945	.09

Notes For Table F1

(a) Ref. Table 8 for description code
(b) Fatigue Crack Origins: B = bore of hole, C = Corner of hole and S = surface crack away from hole
(c) Time to initiate crack depth of 0.010" in fastener hole (determined from fractographic results)
(d) Time-to-failure
(e) Time spent in crack growth
(f) Extrapolation based on power law (Eqs. 1 and 3)
(g) Linear extrapolation from two smallest consecutive crack sizes from fractographic data sheet
(h) Diameter measurement not recorded

FATIGUE TEST DATA

SPECIMEN NUMBER: 66 (Load Trans) 20%

SPECTRUM: 400hr (A)

TEST DATE: 6-30-83 //

W 2.0" TH .2975" HOLE DIAM .4444" A .5950 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast) FM=250

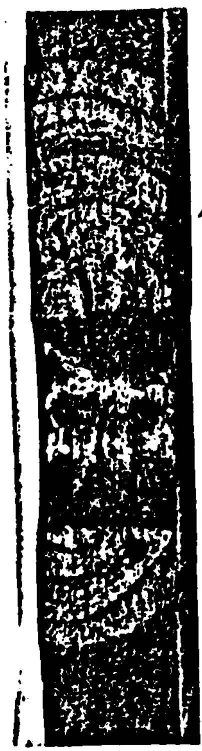
ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 852414 ldpts % LIFE = 111.32

TTCI 3400 FLIGHT HOURS

Smaller Flaw = .249" B

Larger Flaw = .5470" B



2.61X

(F) 22.264

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
22.26	8904	.5470
22	8800	
21	8400	.3790
20	8000	.2720
19	7600	.1870
18	7200	.1275
17	6800	.0820
16	6400	.0625
15	6000	.0480
14	5600	.0320
13	5200	.0250
12	4800	.0220
11	4400	.0190
10	4000	.0145
9	3600	.0115
TTCI 8	3200	.0085
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 68 (20% LT)

SPECTRUM: 400hr (A)

TEST DATE: 7-6-83 //

W 2.0139" TH .3079" HOLE DIAM ______ A .6201 in²

MAX STRESS 28 Ksi FREQ. 1 LIFE = 2 days (Fast)

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 727457 ld pts. % LIFE = 95.0

TTCI 4508 FLIGHT HOURS

Smaller Flaw = .4038" B

Larger Flaw = .4510" B

L

S

2.6X

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	40	16000	
	39	15600	
	38	15200	
	37	14800	
	36	14400	
	35	14000	
	34	13600	
	33	13200	
	32	12800	
	31	12400	
	30	12000	
	29	11600	
	28	11200	
	27	10800	
	26	10400	
	25	10000	
	24	9600	
	23	9200	
	22	8800	
	21	8400	
	20	8000	
(F)	19	7600	.4510
	18	7200	.2365
	17	6800	.1180
	16	6400	.0630
	15	6000	.0360
	14	5600	.0240
	13	5200	.0175
TTCI →	12	4800	.0135
	11	4400	.0085
	10	4000	
	9	3600	
	8	3200	
	7	2800	
	6	2400	
	5	2000	
	4	1600	
	3	1200	
	2	800	
	1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 69 (20% LT)

SPECTRUM: 400 hr (A)

TEST DATE: 7-11-83 //

W 2.0800" TH .3040" HOLE DIAM .445" A .6323 in²

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (Slow) FM=40

ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 536655 ld pts. % LIFE = 70.08

TTCI 1662 FLIGHT HOURS

Smaller Flaw = .152" B

Larger Flaw = .4155" B

2.63X

(F) 14.016

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
14.02	5608	.4155
14	5600	
13	5200	.2230
12	4800	.1545
11	4400	.1265
10	4000	.1025
9	3600	.0840
8	3200	.0635
7	2800	.0490
6	2400	.0275
TTCI → 5	2000	.0165
4	1600	.0090
3	1200	
2	800	
1	400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 70 (20% LT)

SPECTRUM: 400 hr. (A)

TEST DATE: 7-11-83 //

W 2.0065" TH .3040 HOLE DIAM .447" A .6099 in^2

MAX STRESS 28 ksi FREQ. 1 LIFE = 16 days (Slow) FM:40

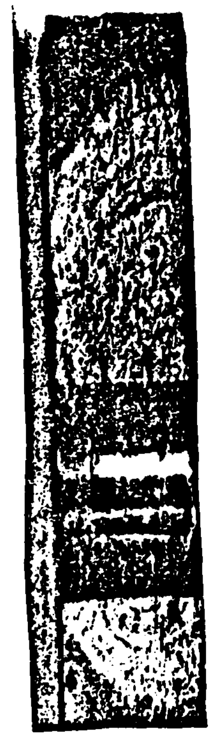
ENVIR. CONDS. 3.5% NaCl PREPS. none

CYCLES TO FAILURE 677380 ld pts % LIFE = 88.46

TTCI 3665 FLIGHT HOURS

Smaller Flaw = .380" B

Larger Flaw = .6415' B



L

(F) 17.69

S

2.63X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
	7068	.6415
17	6800	.3985
16	6400	.2160
15	6000	.1155
14	5600	.0640
13	5200	.0410
12	4800	.0280
11	4400	.0230
10	4000	.0130
9	3600	.0095
8	3200	
7	2800	
6	2400	
5	2000	
4	1600	
3	1200	
2	800	
1	400	

TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: T3 (20% LT)

SPECTRUM: 400 hr (A)

TEST DATE: 7-20-83 //

W 2.0450" TH .3040" HOLE DIAM .4455" A .6217 in²

MAX STRESS 28 FREQ. 1 LIFE = 16 days (Slow) PM=40

ENVIR. CONDS. Dry PREPS. —

CYCLES TO FAILURE 2374269 ld pts % LIFE = 310

TTCI 14,100 FLIGHT HOURS

Smaller Flaw = .300" B

Larger Flaw = .4850" B

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0195
39	15600	.0175
38	15200	.0150
37	14800	.0135
36	14400	.0115
35	14000	.0095
34	13600	
33	13200	
32	12800	
31	12400	
30	12000	
29	11600	
28	11200	
27	10800	
26	10400	
25	10000	
24	9600	
23	9200	
F 62.012	24800	.4850
61	24400	.3895
60	24000	.3085
59	23600	.2605
58	23200	.2135
57	22800	.1780
56	22400	.1530
55	22000	.1300
54	21600	.1095
53	21200	.0900
52	20800	.0790
51	20400	.0690
50	20000	.0600
49	19600	.0525
48	19200	.0455
47	18800	.0405
46	18400	.0360
45	18000	.0325
44	17600	.0300
43	17200	.0260
42	16800	.0240
41	16400	.0220

FATIGUE TEST DATA

SPECIMEN NUMBER: 74 (20% LT)

SPECTRUM: 400hr (A)

TEST DATE: 7-21-83 //

W 2.0350" TH .3036" HOLE DIAM .446" A .6166 in²

MAX STRESS 28ksi FREQ. 1 LIFE = 2days (Fast) PM=250

ENVIR. CONDS. Dry PREPS. none

CYCLES TO FAILURE 1723550 ld pts % LIFE = 225

TTCI 8800 FLIGHT HOURS

Smaller Flaw = .362"B

Larger Flaw = .3855"B

L

S

2.48X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.1405
39	15600	.1150
38	15200	.0950
37	14800	.0765
36	14400	.0630
35	14000	.0560
34	13600	.0495
33	13200	.0445
32	12800	.0395
31	12400	.0355
30	12000	.0320
29	11600	.0295
28	11200	.0255
27	10800	.0225
26	10400	.0190
25	10000	.0170
24	9600	.0150
23	9200	.0120
TTCI 22 →	8800	.0100
21	8400	.0080
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
10	4000	
9	3600	
8	3200	
7	2800	
6	2400	
45	18000	.3855
44	17600	.3320
43	17200	.2470
42	16800	.2025
41	16400	.1690

FATIGUE TEST DATA

SPECIMEN NUMBER: 75 (20% LT)

SPECTRUM: 400hr (A)

TEST DATE: 8-1-83 //

W 2.010" TH .3025" HOLE DIAM .4405" A .6080 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast) FH=250

ENVIR. CONDS. Dry PREPS. ——

CYCLES TO FAILURE 1917739 ld pts % LIFE = 250

TTCI 10,203 FLIGHT HOURS

Smaller Flaw = .330" B

Larger Flaw = .390" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0840
39	15600	.0740
38	15200	.0650
37	14800	.0590
36	14400	.0530
35	14000	.0460
34	13600	.0400
33	13200	.0350
32	12800	.0315
31	12400	.0260
30	12000	.0225
29	11600	.0200
28	11200	.0160
27	10800	.0130
26	10400	
25	10000	
24	9600	
23	9200	
22	8800	
21	8400	
20	8000	
19	7600	
18	7200	
17	6800	
16	6400	
15	6000	
14	5600	
13	5200	
12	4800	
11	4400	
F 50	.088 20000	.3900
49	19600	.3320
48	19200	.2770
47	18800	.2370
46	18400	.2040
45	18000	.1750
44	17600	.1520
43	17200	.1285
42	16800	.1100
41	16400	.0955

L

S

2X

FATIGUE TEST DATA

SPECIMEN NUMBER: 80 (20% LT)

SPECTRUM: 400 hr (A)

TEST DATE: 8-9-83 //

W 1.9995" TH .3035" HOLE DIAM .4410" A .6068 in²

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days (Fast) FM=250

ENVIR. CONDS. Dry PREPS. ——

CYCLES TO FAILURE 2680756 ld pts % LIFE = 350

TTCI 16,800 FLIGHT HOURS

Smaller Flaw = .310" B

Larger Flaw = .388" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	
39	15600	
38	15200	
37	14800	
36	14400	
35	14000	
34	13600	
33	13200	
32	12800	
31	12400	
F 70.016	28000	.3880
69	27600	.2670
68	27200	.2260
67	26800	.1855
66	26400	.1580
65	26000	.1300
64	25600	.1120
63	25200	.0990
62	24800	.0810
61	24400	.0665
60	24000	.0605
59	23600	.0545
58	23200	.0485
57	22800	.0450
56	22400	.0405
55	22000	.0365
54	21600	.0340
53	21200	.0310
52	20800	.0285
51	20400	.0260
50	20000	.0230
49	19600	.0210
48	19200	.0190
47	18800	.0170
46	18400	.0150
45	18000	.0135
44	17600	.0125
43	17200	.0115
42	16800	.0100
41	16400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 308 Load Trans (20%)

SPECTRUM: F18 300hr (B)

TEST DATE: 2-6-84 //

W 2.0010" TH .3030" HOLE DIAM .4405" A .6063 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. DRY PREPS. —

CYCLES TO FAILURE 116727 ld pts % LIFE = —

TTCI 7228 FLIGHT HOURS

LARGER FLAW = .483" B

SMALLER FLAW = .225" B

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
	0		
	9		
F	37.21	11162.9	.483
	37	11100	.441
	36	10800	.338
	35	10500	.280
	34	10200	.234
	33	9900	.193
	32	9600	.153
	31	9300	.120
	30	9000	.096
	29	8700	.078
	28	8400	.064
	27	8100	.047
	25	7800	.020
	25	7500	.016
	24		
	23		
	22		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 309 20% Load Trans.

SPECTRUM: F18-300hr (B)

TEST DATE: 2-7-84 11

W 2.0035" TH .3010" HOLE DIAM .4415" A .6031 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. DRY PREPS. ——

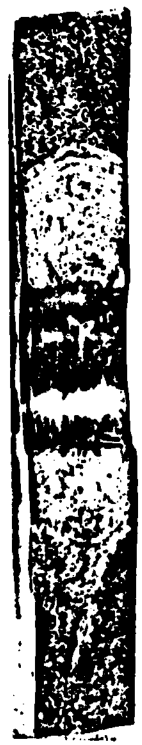
CYCLES TO FAILURE 125862 ld pts % LIFE = ——

blocks = 40.12

TTCI 8100 FLIGHT HOURS

LARGER FLAW = .4075' (B)

SMALLER FLAW = .2945" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
40.12	12037	.4075
40	12000	.390
39	11700	.291
38	11400	.210
37	11100	.1495
36	10800	.094
35	10500	.068
34	10200	.052
33	9900	.0405
32	9600	.0325
31	9300	.027
30	9000	.0225
29	8700	.018
28	8400	.014
27 (TTCI)	8100	.010
—	—	—
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 310 20% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 2-8-84 //

W 1.9990' TH .3020" HOLE DIAM .4435" A .6037 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. DRY PREPS. No

CYCLES TO FAILURE 219972 ld pts % LIFE = TTCI

TTCI 17,115 FLIGHT HOURS

LARGER FLAW = .4195" (B)

SMALLER FLAW = .380" (B)

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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
70	21000	.4045
69	20700	.2870
68	20400	.224
67	20100	.1855
66	19800	.1490
65	19500	.1195
64	19200	.1025
63	18900	.082
62	18600	.0675
61	18300	.0535
60	18000	.042
59	17700	.028
58	17400	.0195
57	17100	.0095
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
F 71.12	21336	.4195

FATIGUE TEST DATA

SPECIMEN NUMBER: 311 20% LT

SPECTRUM: F18-300 hr (B)

TEST DATE: 2-9-84 11

W 1.9995" TH .3020" HOLE DIAM .4435" A .6039 in²

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. DRY PREPS. No

CYCLES TO FAILURE 124602 ldpts % LIFE = —

TTCI 8764 FLIGHT HOURS

LARGER FLAW = .448" (B)

SMALLER FLAW = .4215" (B)

FRACTOGRAPHIC DATA

	BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F	39.72	11916	.448
	39	11700	.344
	38	11400	.231
	37	11100	.165
	36	10800	.1025
	35	10500	.078
	34	10200	.057
	33	9900	.039
	32	9600	.029
	31	9300	.0215
TTCI →	30	9000	.0155
	29	8700	.0085
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0		
	9		
	8		
	7		
	6		
	5		
	4		
	3		
	2		
	1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 332 20% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 2-17-84 11

W 2.0000" TH .3010" HOLE DIAM .4465" A .6020"

MAX STRESS 28 KSI FREQ. Fast (FM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 118764 ld pts.

TTCI 6343 FLIGHT HOURS

LARGER FLAW = .4630" (B)

SMALLER FLAW = .3025" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
F 37.86	11358	.4630
37	11100	.332
36	10800	.2505
35	10500	.1815
34	10200	.166
33	9900	.1455
32	9600	.1290
31	9300	.1175
30	9000	.1030
29	8700	.089
28	8400	.0805
27	8100	.068
26	7800	.054
25	7500	.043
24	7200	.030
23	6900	.023
22	6600	.016
21	6300	.009
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 333 20% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 2-20-84 11

W 2.0005" TH .3030" HOLE DIAM .4415" A .6062"

MAX STRESS 28KSI FREQ. Fast (FM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 149030 ld pts.

TTCI 11311 FLIGHT HOURS

LARGER FLAW = .387" B

SMALLER FLAW = .355" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0	·	
	—	—
F 47.51	14253	.387
47	14100	.268
46	13800	.184
5	13500	.134
4	13200	.094
3	12900	.074
2	12600	.065
1	12300	.046
0	12000	.026
9	11700	.019
8	11400	.011
—	—	—
6	8	
5	5	
4	2	
3	9	
2	6	
1	3	
0	0	
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 334

SPECTRUM: F18-300hr (B)

TEST DATE: 2-21-84 11

W 2.0000" TH .3020" HOLE DIAM .4430" A .6040"

MAX STRESS 28KSI FREQ. Fast (FM=250)

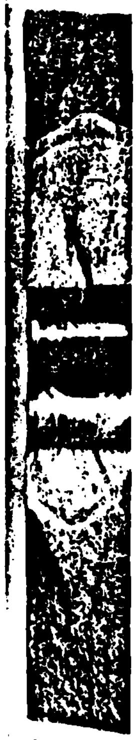
ENVIR. CONDS. 3.5% Nacl PREPS. No

CYCLES TO FAILURE 96805 ld pts

TTCI 6712 FLIGHT HOURS

LARGER FLAW = .4375"(B)

SMALLER FLAW = .2225"(B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
2		
F 30.86	9258	.4735
30	9000	.3280
29	8700	.2500
28	8400	.1910
27	8100	.1385
26	7800	.1050
25	7500	.051
24	7200	.0335
23	6900	.0150
22	6600	.0070
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 335 20% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 2-23-84 //

W 2.0020" TH .3015" HOLE DIAM .4435" A .6036"

MAX STRESS 28KSI FREQ. Fast (FM=250)

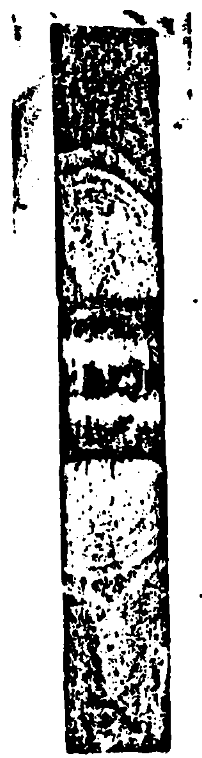
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 103079 ld pts.

TTCI 7799 FLIGHT HOURS

LARGER FLAW = .429"B

SMALLER FLAW = .411"B



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
	—	—
F 32.86	9858	.429
32	9600	.267
31	9300	.216
30	9000	.153
29	8700	.098
28	8400	.067
27	8100	.028
26	7800	.011
—	—	—
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 500 40% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 5-2-84 11

W 2.0025" TH .3065" HOLE DIAM .4455" A .6138"

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 205496 ld pts

TTCI 16,800 FLIGHT HOURS

LARGER FLAW = .373" B

SMALLER FLAW = .347" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
9		
8		
7		
F 65.51	19653	.373
65	19500	.312
64	19200	.244
63	18900	.1855
62	18600	.145
61	18300	.1185
60	18000	.0905
59	17700	.0655
58	17400	.0395
57	17100	.020
TTCI → 55	16800	.010
—	—	—
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

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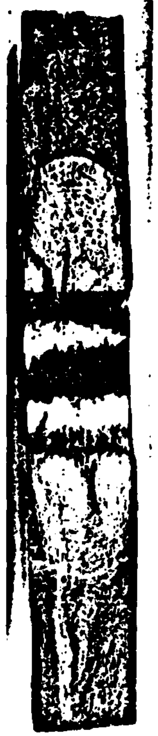

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FATIGUE TEST DATA

SPECIMEN NUMBER: 501 40% LT

SPECTRUM: F18-300hr(B)

TEST DATE: 5-3-84 11

W 1.9995" TH .3020" HOLE DIAM .4460" A .6039"

MAX STRESS 28KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 263889 ld.pts.

TTCI 21522 FLIGHT HOURS

LARGER FLAW = .4425" B

SMALLER FLAW = .4065" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
F 84.12	25236	.4425
84	25200	.384
83	24900	.287
82	24600	.1915
81	24300	.134
80	24000	.098
79	23700	.0685
78	23400	.055
77	23100	.0365
76	22800	.022
75	22500	.0165
TTCI 74	21200	.0085
73		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 502 40% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 5-3-84 11

W 2.0000" TH .3035" HOLE DIAM .4445" A .6070 in²

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. None

CYCLES TO FAILURE 206165 ld pts.

TTCI 16,064 FLIGHT HOURS

LARGER FLAW = .420" B

SMALLER FLAW = .253" B

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
F 65.72	19716	.420
65	19500	.324
64	19200	.282
63	18900	.233
62	18600	.198
61	18300	.123
60	18000	.088
59	17700	.0685
58	17400	.050
57	17100	.033
56	16800	.028
55	16500	.0225
TTCI → 54	16200	.014
53	15900	.005
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 503 40% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 5-7-84 //

W 2.0010" TH .3020" HOLE DIAM .4435" A .6043 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

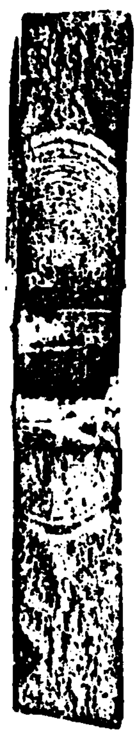
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 93232 ld pts

TTCI 6633 FLIGHT HOURS

LARGER FLAW = .4395" B

SMALLER FLAW = .2565" B



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F 29.72	8916	.4395
29	8700	.3675
28	8400	.2815 retardation
27	8100	.224 observed
26	7800	.140
25	7500	.0955
24	7200	.04555
23	6900	.0195
TTCI → 22	6600	.009
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 504 40% LT

SPECTRUM: F18-300hr (B)

TEST DATE: 5-7-84 //

W 2.0010" TH .3030" HOLE DIAM .4440" A .6063"

MAX STRESS 28KSI FREQ. Fast (FM=250)

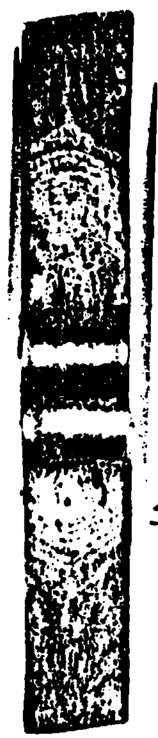
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 119683 ld pts

TTCI 8218 FLIGHT HOURS

LARGER FLAW = .503" B

SMALLER FLAW = .349" B



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
F 38.15	11446	.503
38	11400	.416
37	11100	.296
36	10800	.233
35	10500	.203
34	10200	.1415
33	9900	.103
32	9600	.080
31	9300	.058
30	9000	.044
29	8700	.021
TTCI 28	8400	.014
27	8100	.0075
5		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 505 40% LT

SPECTRUM: F18-300hr(B)

TEST DATE: 5-9-84 //

W 2.0000" TH .3030' HOLE DIAM .4435" A .6060 in²

MAX STRESS 28 KSI FREQ. Fast (FM=250)

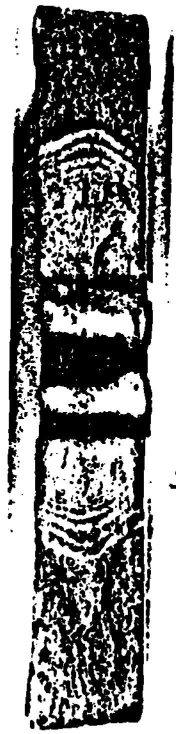
ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 81944 ld pts TTCI →

TTCI 5127 FLIGHT HOURS

LARGER FLAW = .414" B

SMALLER FLAW = .331" B



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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
F 26.12	7836	.414
26	7800	.376
25	7500	.239
24	7200	.178
23	6900	.137
22	6600	.0995
21	6300	.075
20	6000	.055
9	5700	.035
8	5400	.020
7	5100	.0095
6	4800	.005
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 506 40% LT

SPECTRUM: F16 (400 hr) (A)

TEST DATE: 4-16-84 11

W 2.0025" TH .3020" HOLE DIAM .4450" A .6098 sq"

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days, Fast, FH: 250

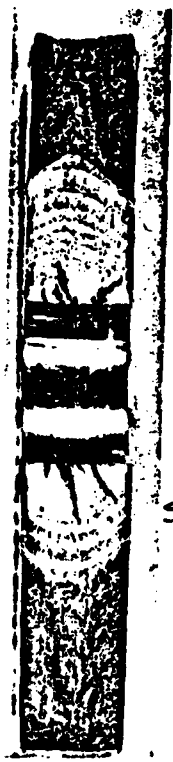
ENVIR. CONDS. Dry PREPS. None

CYCLES TO FAILURE 2377184 ldpts % LIFE = 310

TTCI 11,733 FLIGHT HOURS

LARGER FLAW = .3741" (B)

SMALLER FLAW = .325" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
30	12000	.0110
29	11600	.0095
28	11200	
27	10800	
26	10400	
62	24800	.3741
61	24400	.3084
60	24000	.2624
59	23600	.2257
58	23200	.1952
57	22800	.1634
56	22400	.1385
55	22000	.1190
54	21600	.1030
53	21200	.0886
52	20800	.0778
51	20400	.0701
50	20000	.0631
49	19600	.0575
48	19200	.0522
47	18800	.0480
46	18400	.0444
45	18000	.0412
44	17600	.0383
43	17200	.0359
42	16800	.0335
41	16400	.0312
40	16000	.0290
39	15600	.0271
38	15200	.0252
37	14800	.0232
36	14400	.0215
35	14000	.0194
34	13600	.0176
33	13200	.0158
32	12800	.0142
31	12400	.0126

FATIGUE TEST DATA

SPECIMEN NUMBER: 507 40% LT

SPECTRUM: F16 (400hr)(A)

TEST DATE: 4-17-84 11

W 2.0030" TH .3020" HOLE DIAM .4450" A .6049 sq"

MAX STRESS 28 Ksi FREQ. 1 LIFE = 2days, Fast, Fly:2%

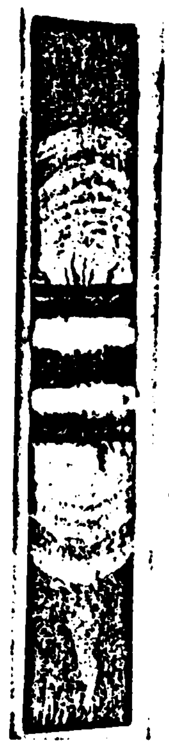
ENVIR. CONDS. Dry PREPS. None

CYCLES TO FAILURE 2872169 ld pts % LIFE = 375

TTCI 16,000 FLIGHT HOURS

LARGER FLAW = .446 (B)

SMALLER FLAW = .375" (B)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FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
40	16000	.0100
39	15600	.0090
38	15200	
37	14800	
75	30000	.446
74	29600	.3387
73	29200	.277
72	28800	.2338
71	28400	.1974
70	28000	.1671
69	27600	.1413
68	27200	.1205
67	26800	.1032
66	26400	.0910
65	26000	.0807
64	25600	.0722
63	25200	.0648
62	24800	.0595
61	24400	.0545
60	24000	.0511
59	23600	.0461
58	23200	.0436
57	22800	.0404
56	22400	.0380
55	22000	.0355
54	21600	.0321
53	21200	.0303
52	20800	.0281
51	20400	.0266
50	20000	.0244
49	19600	.0229
48	19200	.0206
47	18800	.0189
46	18400	.0171
45	18000	.0158
44	17600	.0146
43	17200	.0134
42	16800	.0120
41	16400	.0110

FATIGUE TEST DATA

SPECIMEN NUMBER: 508 40% LT

SPECTRUM: F16-400hr (A)

TEST DATE: 4-23-84 11

W 2.0015" TH .3030" HOLE DIAM .4440" A .6065 sq"

MAX STRESS 28 KSI FREQ. 1 LIFE = 2days, Fast, FM=250

ENVIR. CONDS. Dry PREPS. None

CYCLES TO FAILURE 3446482 ld pts % LIFE = 450

TTCI 22,218 FLIGHT HOURS

LARGER FLAW = .440" (B)

SMALLER FLAW = .360" (B)

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
F 90	36,000	.440
89	35,600	.3189
88	35200	.2635
87	34800	.2249
86	34400	.1931
85	34000	.1700
84	33600	.1447
83	33200	.1282
82	32800	.1127
81	32400	.1022
80	32000	.0930
79	31600	.0845
78	31200	.0770
77	30800	.0698
76	30400	.0697
75	30000	.0584
74	29600	.0537
73	29200	.0495
72	28800	.0456
71	28400	.0411
70	28000	.0370
69	27600	.0337
68	27200	.0310
67	26800	.0282
66	26400	.0265
65	26000	.0250
64	25600	.0234
63	25200	.0217
62	24800	.0203
61	24400	.0180
60	24000	.0167
59	23600	.0150
58	23200	.0132
57	22800	.0116
56	22400	.0105
→ 55	22000	.0094
54	21600	
53	21200	
52	20800	
51	20400	

FATIGUE TEST DATA

SPECIMEN NUMBER: 509 40% LT

SPECTRUM: F16-400hr (A)

TEST DATE: 4-23-84 //

W 2.0010" TH .3015" HOLE DIAM .4450" A .6033 sq"

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days, Fast, FM-250

ENVIR. CONDS. 3.5% NaCl PREPS. None

CYCLES TO FAILURE 1072656 ldpts % LIFE = 140

TTCI 6048 FLIGHT HOURS

LARGER FLAW = .387" (B)

SMALLER FLAW = .285" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
28	11200	.387
27	10800	.2287
26	10400	.1516
25	10000	.1090
24	9600	.0825
23	9200	.0587
22	8800	.0469
21	8400	.0377
20	8000	.0285
19	7600	.0221
18	7200	.0176
17	6800	.0148
16	6400	.0122
15	6000	.0097
2		
1		
0		
9		
8		
7		
6		
5		
4		
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2		
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0		
9		
8		
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6		
5		
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3		
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1		

F

TTCI

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2X

FATIGUE TEST DATA

SPECIMEN NUMBER: 510 40% LT

SPECTRUM: F16-400hr (A)

TEST DATE: 4-25-84 11

W 2.0030' TH .3030' HOLE DIAM .4455" A .6069 sq"

MAX STRESS 28 ksi FREQ. 1 LIFE = 2days, Fast, FM=250 F

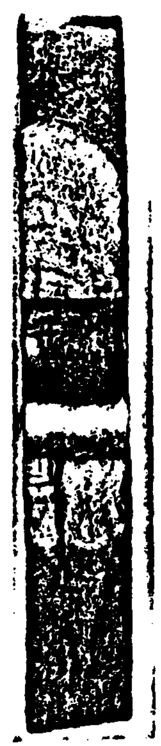
ENVIR. CONDS. 3.5% NaCl PREPS. None

CYCLES TO FAILURE 804656 ldpts % LIFE = 105

TTCI 5143 FLIGHT HOURS

LARGER FLAW = .480" (C)

SMALLER FLAW = .250" (B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
21	8400	.480
20	8000	.2770
19	7600	.1542
18	7200	.0802
17	6800	.0526
16	6400	.0374
15	6000	.0262
14	5600	.0161
13	5200	.0105
12	4800	.0070
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
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TTCI

FATIGUE TEST DATA

SPECIMEN NUMBER: 511 40% LT

SPECTRUM: F16-400hr (A)

TEST DATE: 4-27-84 11

W 2.0015" TH .3000" HOLE DIAM .4455" A .6005 sq"

MAX STRESS 28 KSI FREQ. 1 LIFE = 2 days, Fast, FH=250

ENVIR. CONDS. 3.5% NaCl PREPS. None

CYCLES TO FAILURE 922257 Id pts % LIFE = 120 mi

TTCI 6821 FLIGHT HOURS

LARGER FLAW = .450" (B)

SMALLER FLAW = .125" (B)

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
24	9600	.450
23	9200	.2789
22	8800	.1587
21	8400	.0790
20	8000	.0317
19	7600	.0214
18	7200	.0136
17	6800	.0098
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 521 7070 LT

SPECTRUM: F18-BLOCK

TEST DATE: 5-10-84 11

W 2.0030" TH .3015" HOLE DIAM .4455" A .6039"

MAX STRESS 28KSI FREQ. Fast (FM=250) F

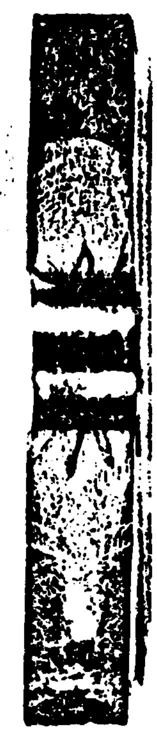
ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 319975 ld pts.

TTCI 8481 FLIGHT HOURS

LARGER FLAW = .377" (I)

SMALLER FLAW = .367" (B)



L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3	—	—
102	30600	.377
101	30300	.340
100	30000	.298
99	29700	.270
98	29400	.259
97	29100	.237
96	28800	.217
95	28500	.203
—	—	—
85	25500	.108
—	—	—
75	22500	.064
—	—	—
65	19500	.040
—	—	—
55	16500	.035
—	—	—
45	13500	.019
—	—	—
2		
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 522 40% LT

SPECTRUM: F18- BLOCK

TEST DATE: 5-10-84 11

W 2.0010" TH .3015" HOLE DIAM .4470" A .6033"

MAX STRESS 28KSI FREQ. Fast (FM=250) F

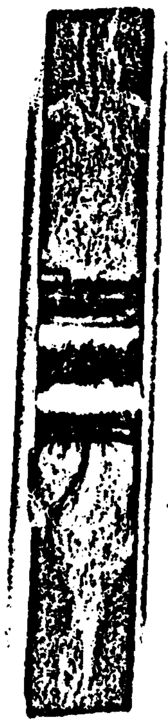
ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 348207 ld pts

TTCI 16,200 FLIGHT HOURS

LARGER FLAW = .525"(B)

SMALLER FLAW = .361"(B)



FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
3		
2	—	—
111	33300	.525
110	33000	.450
109	32700	.382
108	32400	.333
107	32100	.305
106	31800	.284
105	31500	.265
—	—	—
95	28500	.150
—	—	—
85	25500	.076
—	—	—
75	22500	.040
—	—	—
65	19500	.024
—		
55	16500	.011
TTCI → 54	16200	.010
—	—	—
1		
0		
9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 523 40% LT

SPECTRUM: F18 BLOCK

TEST DATE: 5-14-84 //

W 2.0020" TH .3020" HOLE DIAM .4465" A .6046" F

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. Dry PREPS. No

CYCLES TO FAILURE 420359 ld pts

TTCI 21278 FLIGHT HOURS

LARGER FLAW = .439" (B)

SMALLER FLAW = .333" (B)

L

S

2X

TTCI →

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
134	40200	.439
133	39900	.401
132	39600	.371
131	39300	.338
130	39000	.306
—	—	—
120	36000	.171
—	—	—
110	33000	.096
—	—	—
100	30000	.059
—	—	—
90	27000	.038
—	—	—
80	24000	.021
—	—	—
70	21025	.009
—	—	—
4		
3		
2		
1		
0		
9		
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7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 524 (OPEN HOLE)

SPECTRUM: F18 BLOCK

TEST DATE: 5-14-84 //

W 2.0000" TH .2995" HOLE DIAM .5030' A .5990 F

MAX STRESS 28KSI FREQ Fast (FM=250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 141165 ld pts.

TTCI 6900 FLIGHT HOURS

LARGER FLAW = .425" (B)

SMALLER FLAW = .293" (B)

L

TTCI →

S

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
45	13500	.425
44	13200	.36
43	12900	.274
42	12600	.215
41	12300	.185
40	12000	.159
39	11700	.139
38	11400	.115
37	11100	.096
36	10800	.081
35	10500	.071
34	10200	.055
33	9900	.048
32	9600	.043
31	9300	.039
30	9000	.032
29	8700	.027
28	8400	.023
27	8100	.020
26	7800	.018
25	7500	.015
24	7200	.013
23	6900	.010
2		
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9		
8		
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 525 (OPEN HOLE)

SPECTRUM: F18 BLOCK (B')

TEST DATE: 5-16-84 11

W 1.9965" TH .3005" HOLE DIAM .5030" A .5999"

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. 3.5% NaCl PREPS. No

CYCLES TO FAILURE 144302 ld pts

TTCI 6600 FLIGHT HOURS

LARGER FLAW = .376" (B)

SMALLER FLAW = .267" (B)

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
46	13800	.376
45	13500	.325
44	13200	.265
43	12900	.192
42	12600	.163
41	12300	.139
40	12000	.117
39	11700	.100
38	11400	.091
37	11100	.084
36	10800	.076
35	10500	.070
34	10200	.064
33	9900	.059
32	9600	.054
31	9300	.047
30	9000	.042
29	8700	—
28	8400	.028
27	8100	—
26	7800	.019
25	7500	—
24	7200	.014
23	6900	—
TTCI → 22	6600	.010
7		
6		
5		
4		
3		
2		
1		

FATIGUE TEST DATA

SPECIMEN NUMBER: 526 (OPEN HOLE)

SPECTRUM: F18 BLOCK (B')

TEST DATE: 5-17-84 11

W 2.0025" TH .3005" HOLE DIAM .5045" A .6017"

MAX STRESS 28 KSI FREQ. Fast (FM = 250)

ENVIR. CONDS. 3.5 % NaCl PREPS. No

CYCLES TO FAILURE 103521 ld pts.

TTCI 955 FLIGHT HOURS

LARGER FLAW = .575" (C)

SMALLER FLAW = .432" (B)

L

S

2X

FRACTOGRAPHIC DATA

BLK #	FLIGHT HRS.	CRACK LENGTH IN.
0		
9		
8		
7		
6		
5		
4		
F 33	9900	.575
32	9600	.405
31	9300	.326
30	9000	.278
29	8700	.249
28	8400	.228
27	8100	.205
26	7800	.192
25	7500	.181
24	7200	.157
23	6900	.150
22	6600	.142
21	6300	.138
20	6000	.133
—	—	—
15	4500	.098
—	—	—
10	3000	.040
—	—	—
5	1500	.018
3		
2		
1		
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5		
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